INTRODUCTORY PSYCHOLOGY FOR TEACHERS

REVISED

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BY

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To My Father and Mother

CONTENTS

BOOK ONE

BOOK TWO

INTRODUCTORY PSYCHOLOGY

BOOK ONE

LESSON 1

WHAT IS PSYCHOLOGY?[1]

Some of you are doubtless familiar with the story from which the following incident is quoted. But it bears repeating.

Sam had never told his love; he was, in fact, sensitive about it. This meeting with the lady was by chance, and although it afforded exquisite moments, his heart was beating in an unaccustomed manner, and he was suffering from embarrassment, being at a loss, also, for subjects of conversation. It is, indeed, no easy matter to chat easily with a person, however lovely and beloved, who keeps her face turned the other way, maintains one foot in rapid and continuous motion through an arc seemingly perilous to her equilibrium, and confines her responses, both affirmative and negative, to "U-huh."

Altogether, Sam was sufficiently nervous without any help from Penrod, and it was with pure horror that he heard his own name and Mabel's shrieked upon the ambient air with viperish insinuations.

"Sam-my and May-bul! Oh, Oh!"

Sam started violently. Mabel ceased to swing her foot, and both encarnadined, looked up and down and everywhere for the invisible but well-known owner of that voice. It came again, in taunting mockery.

"Sammy's mad, and I am glad,
And I know what will please him,
A bottle of wine to make him shine,
And Mabel Rorebeck to squeeze him!"

[1] The attention of instructors is called to a booklet of instructions in which suggestions are made as to assignments, necessary laboratory material, and procedure in some of the experiments.

"Fresh old thing!" said Miss Rorebeck, becoming articulate. And, unreasonably including Sam in her indignation, she tossed her head at him with an unmistakable effect of scorn. She began to walk away.

"Well, Mabel," said Sam plaintively, following, "it ain't my fault. I didn't do anything. It's Penrod."

"I don't care—" she began pettishly, when the viperish voice was again lifted.

"Oh, oh, oh!
Who's your beau?
Guess I know:
Mabel and Sammy, oh, oh, oh!
I caught you!"

Then Mabel did one of those things which eternally perplex the slower sex. She deliberately made a face, not at the tree behind which Penrod was lurking but at the innocent and heart-wrung Sam. "You needn't come limpin' after me, Sam Williams!" she said, though Sam was approaching upon two perfectly sound legs. And then she ran away at the top of her speed.

"Run, nigger, run—" Penrod began inexcusably. But Sam cut the persecutions short at this point. Stung to fury, he charged upon the sheltering tree in the Schofields' yard.[1]

Why is it that this account is interesting to us? Why did Sam and Mabel enjoy being together? Why were they so nervous and uneasy? Why did Penrod call out as he did? Why did Mabel get mad at Sam? Why did she run away? Why did Sam get mad? What happened when Sam reached Penrod?

At this point some of my readers may stop and, with lifted eyebrows, question silently, "Is this a game of twenty questions? And twenty foolish questions at that? Can this be psychology?"

It is. All these questions are real psychological problems, quite as pertinent to the science of psychology as the dignified and dry-as-dust queries you doubtless expected.

What then is psychology?

In commencing any new course of study it is necessary to have some idea of what the whole thing is about. At the same time

[1] Booth Tarkington—*Penrod and Sam*, 1916, p. 220ff.

it is extremely difficult to obtain a clear notion since most of the details are unknown to the beginner. It is only after one has experienced details that he is in a position to understand any summary of them. Consequently the following definition is just to aid the reader in orienting himself. Only toward the end of the course will he be prepared to grasp its full meaning.

Psychology may best be defined as the science of behavior.

There is the definition. The matters dealt with in the next ten sections will give some of the various fields included in its bounds.

1. A crowd surrounded the automobile of Dr. John Linder yesterday, when the physician stopped at Glenmore and Vesta Avenues after a dog had dodged beneath the auto's wheels and had been killed. There were men and women in the throng and they seemed to think that the physician had not tried to avoid the dog.

Dr. Linder endeavored to explain that the most expert of motorists could not have dodged the dog, which ran barking beside the wheels of his auto and finally slipped under them. The crowd muttered angrily about motorists who had no thought for human lives, let alone the life of a dog, and Dr. Linder, realizing that the crowd soon might become dangerous, tried to start his car.

His action aroused several men in the crowd who had been working themselves into a fury, and one of them struck out at the doctor with his fist. The physician ducked, and reaching in his pocket, jerked out a glittering object of nickel which he thrust into his assailant's face, exclaiming:—

"Stand off. Get back from this car. I'll shoot the first man who interferes with me."

The man who had struck at the physician, with all the rest of the crowd, fell back hastily, and Dr. Linder, seizing the opportunity, applied the power to his car and slipped away. John Cargill, a blacksmith of the neighborhood, noted the number of of the doctor's car, however, and hurried to the New Jersey Avenue Court where he got a summons for the physician, calling on him to show cause why he shouldn't be punished for violation of the Sullivan Law against carrying weapons. The physician had scarcely arrived at his home when the summons was served and he hurried back to court in his automobile.

Cargill was present and Dr. Linder, after explaining the acci-

dent to Magistrate Naumer, declared that Cargill had been particularly aggressive.

"He had a mob at his back," said the doctor, "and I was really afraid they would attack me."

"But your revolver?" questioned Magistrate Naumer. "Do you not know that under the present law you may not carry a weapon without a permit?"

"Why, I only threatened the crowd with this," replied the physician as he pulling something from his pocket and snapped it into the Magistrate's face. There was a small report, and Magistrate Naumer clutched spasmodically at the desk in front of him. Then he burst into a laugh as he observed the glittering nickel cigar lighter which Dr. Linder held in his hand.

Dr. Linder would not make a charge against Cargill, and the smith hurried out of the courtroom to the accompaniment of laughter in which every one joined.[1]

Why should a crowd become angry because a dog had been killed? Would Cargill have become as angry if he had been alone as he did when surrounded by a crowd? Why did the crowd think Dr. Linder had a gun? Why did Cargill want the Doctor arrested? Why did the crowd in the courtroom all laugh at Cargill? Why have you also enjoyed Cargill's discomfiture?

2. A frequent sight is that of little boys fighting. Why do they like to fight? Why does a woman want to stop this fighting? Why will men pay half a million dollars to sit in the broiling sun and see a prize fight?

3. Consider any advertisement before you. What situation is depicted? Does it in any way express your feelings? Could the advertisement be changed so that it would present a situation that would make you really want the commodity advertised?

4. Consider the following cases :—

(1) A college professor discovers that a wealthy old bachelor keeps a large amount of money hidden in his house. After weeks of clever work he discovers where this money is kept and finally obtains a pass key. One night he enters the house, secures the money and on being discovered by the old man, kills him.

[1] New York Times, 1911.

(2) A young man by the name of Black from a prominent family is engaged to marry Miss Smith. Mr. Jones, although knowing of the engagement, deliberately makes love to Miss Smith and eventually supplants Black. When Black discovers the fact, in a fury of rage, he kills Jones.

(3) C is attacked by a burglar in his own home and after a struggle kills the burglar.

(4) D recklessly drives his auto through the streets of a village and kills a young boy.

(5) E attacks two little boys in the woods and after torturing them for some time, finally cuts one of them to pieces with a razor.

In these five cases a man has killed another human being. Each is a murderer. Why shouldn't all be hanged for their crime? Your answer, of course, is that the circumstances are different. Can we conclude that the five men are different sorts of men on the basis of the circumstances which are presented? How can we evaluate their conduct? in terms of their action, or in terms of the situations which confronted them, or in terms of both situation and response?

5. All respectable school teachers spend some time every year condemning prize fights, bull fights, gambling, drinking, etc. Especially is this true of women teachers. Yet two of my acquaintances when visiting the exposition at San Diego several years ago, rode down to Tia Juana, in Mexico, and very much enjoyed a prize fight, lost a quarter at each of the gambling tables in the "joint" there, and afterwards loudly berated their fate because they arrived too late for the bull-fight. Is it conceivable that the difference in the situations which confront them at home, in the school, or at Tia Juana, is responsible for strong condemnation of a prize fight in one place and attendance at and enjoyment of one in another place?

Do you think it possible to set down all the details making up the situation which confronts one and then to record the response made to this complex situation? If we knew all the details would we be able to prophesy what a person would do? Cannot I be certain that you will say to yourself "7" and then "cat" after reading the next two sentences? What does 3 and 4 make? What does c-a-t spell?

6. A man, walking with a friend in the neighborhood of a country village, suddenly expressed extreme irritation concerning the church bells, which happened to be pealing at the moment. He maintained that their tone was intrinsically unpleasant, their harmony ugly, and the total effect altogether disagreeable. The friend was astonished, for the bells in question were famous for their singular beauty. He endeavored, therefore, to elucidate the real cause underlying his companion's attitude. Skilful questioning elicited the further remark that not only were the bells unpleasant but that the clergyman of the church wrote extremely bad poetry. The causal "complex" was then apparent, for the man whose ears had been offended by the bells also wrote poetry, and in a recent criticism his work had been compared very unfavorably with that of the clergyman. The "rivalry-complex" thus engendered had expressed itself indirectly by an unjustifiable denunciation of the innocent church bells. The direct expression would, of course, have been abuse of the clergyman himself or of his works.

It will be observed that, without the subsequent analysis, the behavior of the man would have appeared inexplicable, or at best ascribable to "bad temper," "irritability," or some other not very satisfying reason. Most cases where sudden passion over some trifle is witnessed may be explained along similar lines, and demonstrated to be the effect of some other and quite adequate cause. The apparently incomprehensible reaction is then seen to be the natural resultant of perfectly definite antecedents.[1]

Did you ever "fly off the handle" at a perfectly innocent person? Have you ever ridiculed a person's clothes when the only trouble with the clothes was that the wearer had beaten you out in an examination? If your friends were aware of one or more of such complexes, as Hart has described above, would it help them in understanding your conduct? Would it help them to prophesy what you would do next?

7. Now I want to be a nice, accommodating patient; anything from sewing on a button, mending a net, or scrubbing the floor, or making a bed. I am a jack-of-all trades and master of none! (Laughs! notices nurse.) But I don't like women to wait on me

[1] B. Hart, *The Psychology of Insanity*, 1912, p. 73f.

when I am in bed; I am modest; this all goes because I want to get married again. Oh, I am quite a talker; I work for a New York talking machine company. You are a physician, but I don't think you are much of a lawyer, are you? I demand that you send for a lawyer. I want him to take evidence. By God in Heaven, my Saviour, I will make somebody sweat! I worked by the sweat of my brow. (Notices money on the table.) A quarter; twenty-five cents. IN GOD we trust; United States of America; Army and Navy Forever!"[1]

The preceding paragraph and the one that follows are verbatim copies of the remarks of two different individuals. The former is that of a maniac and illustrates what is called "flight of ideas;" the latter is that of a dementia præcox patient and illustrates "incoherent speech."

"What liver and bacon is I don't know. You are a spare; the spare; that's all. It is Aunt Mary. Is it Aunt Mary? Would you look at the thing? What would you think? Cold cream. That's all. Well, I thought a comediata. Don't worry about a comediata. You write, he is writing. Shouldn't write. That's all. I'll bet you have a lump on your back. That's all. I looked out the window and I didn't know what underground announcements are. My husband had to take dogs for a fit of sickness.[2]

Offhand one wouldn't say that there was any order or system to these two paragraphs, particularly the second one. And experts have more or less held that view until recently, when careful study commenced to show that there were rules and principles underlying even the ravings of the insane. Some day these will be as thoroughly understood as are physical and chemical laws today.

8. Beliefs have been held as peculiarly one's own, and so intangible that no one until recently has dreamed of measuring them. Yet below there are given nine beliefs making up a sort of scale extending from absolute belief (100) through doubt (0) to absolute disbelief (−100). This scale is very imperfect,

[1] J. R. deFursac, *op. cit.*, p. 72.

[2] J. R. deFursac, *Manual of Psychiatry*, translated by A. J. Rosanoff, 1908, p. 71.

being based on but a limited number of men and women, but it illustrates what can be done along the line of measuring intangible things.

2 plus 2 equals 4.	**99**
There exists an all wise Creator of the world	**73**
A house-fly has six feet	**47**
The most honest man I know will be honest ten years from now.	**21**
"Blessed are the meek for they shall inherit the earth."	**− 2**
Magna Charta was signed in 1512.	**−22**
"It never rains but it pours."	**−53**
"Only the good die young."	**−74**
2 plus 4 equals 7.	**−99**

If one wishes to determine, for example, how strongly he believes that "dark-haired girls are prettier than light-haired ones," he can compare it with those statements above and so obtain a rating for it. The writer cannot comprehend why the average man should rate this belief half way between the fifth and sixth beliefs on the "scale," and the average woman half-way between the sixth and seventh. But they do.

9. From the New York Times of about May 1, 1914, is quoted the following editorial comment on an article by a Superintendent of a Connecticut brass works which appeared in *The Iron Age.*

At these works there was recently constructed a long incline up which heavy loads were to be wheeled in barrows, and premiums were offered to the men who did or exceeded a certain amount of this labor. They attempted it vigorously, but none succeeded in earning any of the extra money, instead they all fell considerably below the fixed task.

Prompt investigation by an expert disclosed that the trouble lay in the fact that the men were working without sufficiently frequent periods of rest. Thereupon a foreman was stationed by a clock, and every twelve minutes he blew a whistle. At the sound every barrowman stopped where he was, sat down on his barrow, and rested for three minutes. The first hour after that was done showed a remarkable change for the better in accomplishment; the second day the men all made a premium allowance by doing

more than what had been too much; and on the third day the minimum compensation had risen, on the average, 40 per cent, with no complaints of overdriving from any of the force.

Apparently a man can do more physical labor by working 12 minutes and resting 3 minutes out of every 15 than he can if he works all of every 15 minute period throughout the day. This principle is one of the fundamental principles underlying scientific management, which has been so much discussed of late in various publications. Possibly this principle might be utilized by you in your daily life. But you may need to know considerably more of the whole subject before making the proper application of it to your particular type of work.

10. How long does it take to say the alphabet? And how much time is required for one to say it backwards? And having said it once will one be able to recite it faster on a second trial? In Plate I is shown graphically just how much time is required to recite the alphabet forwards (i. e., 6.0 seconds) and backwards (i. e., 46.0 seconds), and furthermore how much time is required for each successive recitation up to twenty times. An average adult will decrease his time from 6.0 to 4.0 seconds in the one case and from 46.0 to 12.5 seconds in the second case.

Why do we thus improve with practice? And how is the improvement accomplished? Where are the changes registered? Such a simple performance as that of saying the alphabet is after all very complicated. Watching a child mastering its intricacies gives us some little appreciation of this fact. Involved in this case are many of the problems of education—problems which are also fundamental psychological ones. We meet similar problems on every hand. Today a human being may be unable to use a typewriter, or swim, or dance, or play golf, or run a motor boat; he may know nothing about banking, or politics, or how to broil a steak, or make a cake, or trim a hat. Yet in a short time we may find he has acquired any or many of these performances. This is such a common occurrence we pay little attention to it. But the more we consider the matter the more we should marvel at it. How does a person learn to typewrite? How comes it that his fingers hit the right keys although his eyes are on the sheet from which he is copying? Or take

Plate I.—Showing the time required (seconds) to recite the alphabet forwards (Curve A) and backwards (Curve B) for twenty successive trials. Data based on the records of eight adults.)

another experience through which we have all gone. How have we come to know that 7 plus 6 is 13 or that 7 times 6 is 42? Have all persons learned these two performances in the same way? Is there one best way to learn them? If so, what is it? Why is it that some never can learn such things—for we have known boys and girls and even men and women who can't.

What has been given in this chapter could be extended indefinitely so as to bring in incidents dealing with the differences between whites and negroes or Chinese; problems dealing with poverty and its origin, or with success and its causes; questions concerning delinquency in court or truancy in school; methods of selecting salesmen for a great corporation or telephone girls for thetelephone co. In fact, it may be extended so as to include any and every relation that exists or may ever exist between man and man. All of these subjects may be discussed and many are discussed in other divisions of knowledge, such as history, economics, sociology, anthropology, psychiatry, criminology, advertising, salesmanship, education, etc., but all belong in the science of psychology.

Psychology has been defined as the *science of behavior*. It is concerned with the orderly presentation of the facts and laws which underlie human conduct. It not only includes this but also takes in the whole realm of living beings. Today psychologists are not only studying how man behaves and how he learns but also how rats, and guinea pigs, and monkeys, and birds, and even earthworms, behave and how they learn. This work with animals may seem foolish but it has already led to a better understanding of many phases of human behavior and undoubtedly will lead to very much more.

Psychology has not always been defined in this way. In earlier days it was defined as the "science of the soul" or the "science of mind." Both of these definitions led to insurmountable difficulties and have been discarded. A third definition, i. e., "psychology is the science of consciousness," is still held by many psychologists. With such a definition one is led to emphasize conscious acts and more particularly the content of consciousness to the exclusion of such phenomena as are popularly grouped under the headings of behavior and conduct. But of late, the definition upheld in this book has been adopted by more and more psychologists.

And the field of psychology is being deliberately broadened so that it shall include all of man's activity of every sort and kind. At the present time it is quite clear that those who uphold the definition of psychology as the science of consciousness are little or not at all interested in applied psychology, while those who have espoused the definition of psychology as the science of behavior are also those who have been most active in the application of psychology to advertising, salesmanship, vocational guidance, medical and legal problems, etc.

Such a great subject as man's behavior cannot be covered in a few pages or in a few weeks. A beginning course must commence at some point and develop it in a systematic manner. This means that only certain things can be considered here. What shall those things be? Primarily, we shall consider how man learns. This will lead into many related phases of man's conduct and, of course, if quite thorough would sooner or later touch all of man's behavior. But to attempt such a complete investigation would be too tremendous an undertaking. We shall have to be content with a general survey of the learning process with special reference to learning in the school. We shall take up one example after another; we shall actually learn things in order to have fresh in our minds just how it feels to learn; we shall compare our progress with that of others in order to see how individuals differ; and we shall compare one performance with another in order to draw up general principles and laws which will explain what learning is and how it is accomplished.

After considering some of the principles underlying the way in which man learns and how men differ, particularly in learning, we shall consider third what men want, or, in other words, why men act as they do. As a corollary we shall further consider how one may get another to do as he desires. The applications throughout will be to the problems of education, but many will be taken from other fields of activity in order to illustrate the common relationship to be found among all of man's activities.

LESSON 2

COMPONENTS OF BEHAVIOR

Human behavior is very complicated. Because it is so, the usual practice in commencing its study is to consider examples that have been artificially made simple. There are advantages in such a procedure, but the writer believes that there are even more disadvantages. What is wanted here is that the student shall deduce his psychological principles from everyday experiences and so be able to use what psychology he possesses at all times. Consequently an actual lesson in *sight-spelling,* as it is called, taken from a first grade in the grammar school, will be used as an illustration of certain fundamental psychological principles.

The Sight-Spelling Lesson

The sight-spelling lesson is employed by many teachers in the elementary school to train children in spelling. It consists essentially of showing a word for a moment and then requiring the child to reproduce the word in writing. It is one of the methods used in training pupils to read words, and even sentences, before they know their letters.

Relationship of a Sight-spelling Lesson to Lessons in Reading and Writing.—In order to get the right setting for the understanding of a sight-spelling lesson it will be necessary to go back and get clearly in mind just what a teacher has attempted to accomplish before commencing the teaching of spelling. This preliminary work as given in a typical school can be roughly divided into four steps:

First. The children relate their experience in class.—Day after day the children are encouraged and led to talk about things that interest them.

Second. These experiences are written on the board.—On a Monday about three weeks after the opening of school, the children are asked for example, to tell their experiences since

last Friday. One little boy may reply as follows, his sentences being written on the board as he gives them:—

"I went to the country on Saturday.

"I played with Fred.

"We played leapfrog.

"We played ball.

"We had a happy time."

The children are here given a clear conception of the fact that what they say may be recorded on the board—that writing has something to do with their very thoughts.

Third. Drill is commenced leading to "recognition" of the sentences, phrases and words.—The teacher asks: "Who can find where it says, 'I went to the country on Saturday'? . . . Who can find where it says, 'We played leapfrog'? . . . Where does it say, 'We played ball'? . . . Where does it say, 'I played with Fred'?" etc. At first these sentences are remembered largely because of their *position* on the board. The child remembers the order in which the sentences occurred and makes his guesses accordingly. Soon, however, the recognitions are made in terms of the *form* of the whole sentence.

Right from the start whole sentences or phrases or words are thus drilled upon. Slowly for some children, more quickly for others, the forms of the words or sentences are remembered and connected with their sound. As the word is pronounced by the teacher and then pointed to by some child, the teacher rewrites the word and calls their attention to the fact that "This (pointing to the written word) always says 'ball.'" After three or four days of such work in which the question has been all the time, "where is this," the children are ready for the fourth step.

Fourth. Drill is given leading to "recall" of the sentences, phrases and words.—Here the characteristic question is, "What does this say?" The child here must verbally reproduce from memory the words and sentences as the teacher points to the written symbols. Here again, as the words are pointed to and then named by the child, the teacher frequently rewrites the word (for example, "ball") at the side of the sentence and says, "This always says ball."

At this point writing may be introduced to the child. The teacher choosing some particular word, asks the children to watch her write it. The children watch the word as it is written

and after it has been erased go to the board and write it as best they can.

The fourth step is really two steps—one deals with the recall of the sound of the word when it is seen (reading); the other deals with the reproduction of the form of the word after it is seen (writing). The former means that the child will properly move the muscles of his speech organs when confronted by the sight of the word; the other that he will properly move the muscles of his fingers and arm when confronted by the sound of the word.

In a diagrammatic way we can illustrate these two processes as follows:—

Reading.	Seeing word "ball"	saying the word "ball."
Writing.	Seeing word "ball"	writing the word "ball."
Writing.	Hearing the word "ball"	writing the word "ball."

The method of developing the second part of this process of "recall" is called "sight-spelling." It might more properly be called "sight-writing," for the emphasis in the drill is upon a reproduction of the form of a word previously seen, but not now present to sight.

The Sight-spelling Lesson in Detail.—The procedure in a sight-spelling lesson is as follows: The teacher pronounces the word "ball," then writes it on the board at the usual rate of writing, then pronounces the word "ball" again, allows the children to look at it for a moment, and erases it. Then she tells them that she is going to call upon them to go to the board and write the word there. She then rewrites the word, pronouncing it as she does so, and may have the class also pronounce it. After they have looked at it for a moment, she erases it. Then one or more children are sent to the board to write the word. Some of the children may get it correctly while others will fail. Those who have failed may be given one or more chances to see the word written again or not as the teacher is disposed. Then another word is presented and the procedure is repeated. (One of the most important elements in the whole process is the matter of having the child watch the teacher as she writes the word. It is not enough for the child to see the completed word, *he must see it as it is written.* Otherwise, he may attempt to write it backwards or in some other way than the correct method.)

As this drill is continued each child learns how best to utilize

his time while the word is exposed on the board so as to be able to write the word later. These methods which children adopt have not been worked out by adults as yet. When they are understood in all probability we shall be able to help the child develop the best method for him. What actually takes place, no matter how it is done, is that the child sees the word written on the board and then after it is erased goes to the board and reproduces the form of the word as he has previously seen it. (Of course it is not meant that the reproduction is anything but an approximation at first, but with practice there results a fairly good imitation of the teacher's form.)

Summary.—The above paragraphs have presented (1) what a sight-spelling lesson is, (2) the relationship between a sight-spelling lesson and other lessons in the first grade which have led up to it and (3) the detailed elements in a sight-spelling lesson. We now have a general idea of the relationship of spelling to conversation (oral expression), reading and writing.

The Three Components of Behavior—Situation, Bond and Response[1]

At this stage in the course it will be impossible to discuss in detail the various steps relating to the sight-spelling lesson or to work out the various psychological principles involved in any one step. To do so properly would necessitate a fairly complete knowledge of psychology—the very thing we, of course, do not have at our disposal just now.

For the present it will be sufficient to get clearly in mind one big conception which the following three questions and their answers will present.

What is the Object of the Lesson?—Evidently, to teach the children how to spell the words presented. Or possibly a better answer is—to arrange matters so that the children will learn the spelling of certain words. Consequently, every detail in the whole lesson (every act or idea of teacher or child) is related to this central proposition "the child learning." (And conversely, if there is any detail which does not actually aid the child to learn, it is out of place.)

[1] Of the three components mentioned here, the first and third alone will be discussed in this lession; the "bond" will be taken up in the following lesson.

How May All the Details in the Entire Lesson be Divided into Two Groups as They Relate to the Child's Learning?—On the one hand the child *sees and hears* certain things; that is, the child is influenced by certain things and, on the other hand, the child *does* certain things. All the actions of the teacher, whether spoken words, written words, or gestures—all influence the child. Likewise, all the actions of other children in the room influence the child. And because of all this the child makes certain responses. Obviously then the details in any lesson fall into the two groups, (1) those which influence the child, and (2) those which constitute the child's reaction.

How May We Designate these Two Groups of Details Which Make Up the Spelling Lesson?—All those details of the lesson which go to influence the child, all combined together, we may call the *Situation*. And all those details which constitute what the child does, we may call the *Response*.

To illustrate these two terms, take this single incident in a spelling lesson. Following a discussion of a "leaf" and the writing of sentences on the board concerning a leaf the teacher then turns to the matter of teaching the writing of the single word. She turns and writes the word "leaf" on the board. Pointing to the word on the board, she announces, "This is the word 'leaf.'" Then she erases the word. "Now I am going to write the word 'leaf' again on the board. I want you to watch carefully and see how I do it. After I have written it on the board, I am going to erase it. Then I am going to ask you to come to the board and write it."

The *Situation* confronting any child, for example, Carl, and his *Response* can diagrammatically be expressed as follows:

Situation	Response
1. Carl in school. 2. Presence of teacher and schoolmates. 3. Preceding events concerning a "leaf." 4. Teacher's instructions about noticing the word on the board and then reproducing it after she has erased her writing.	General state of attention (*a*) to class, (*b*) to teacher, and (*c*) to specific topic under discussion.

The teacher next goes on to say, "Now look carefully and get a good picture of 'leaf.'" She then writes the word on the board,

waits a moment, and then erases it. Then she calls on Carl to write the word on the board. Carl goes to the board and writes the word in his crude style of handwriting.

The situation confronting Carl and his response are:

SITUATION	RESPONSE
1, 2, 3, and 4 above (*continued*). 5. Teacher writes the word "leaf" on the board. 6. Teacher erases word. 7. Teacher calls on Carl to write word on board.	(*d*) Carl rises from seat, (*e*) walks to board, (*f*) writes word "leaf" on board, and (*g*) returns to his seat.

Because Carl has done well the teacher nods her approval. This can be represented in the same way:

SITUATION	RESPONSE
1, 2, and 7 (*continued*). 8. Carl's "leaf" on board. 9. Teacher nods her approval of his performance.	(*h*) Carl feels pleased.

It is evident that the *Situation* comprises the details which influence Carl in any way, while it is also evident that the *Response* comprises all the details of Carl's behavior in responding to the situation. It is equally evident that the Situation and the Response are very complicated, being made up of many details.

The first point to get in this course is that the learning process can be and must be resolved into the two factors "Situation" and "Response." All learning is the doing of something (Response) because of the influence exerted by certain other things (Situation).

Assignment to be Prepared for the Next Class-hour

1. Be prepared to give the steps in a sight-spelling lesson, distinguishing particularly between the "recognition" and "recall" processes.

2. Be prepared to discuss this lesson in terms of the two components—situation and response.

3. Write out your analysis of Sam's behavior as given in the quotations from *Penrod and Sam* on page 1. In order to handle such material in the easiest manner it is best to break the

story up into very short "scenes." (Thus the incident about Carl, above, was divided into three scenes.)

The first four scenes would be expressed diagrammatically as follows:

SITUATIONS CONFRONTING SAM	RESPONSES OF SAM
1. Sam in love with Mabel. 2. Meets Mabel on the street.	(a) Stops and talks with Mabel.
1, 2 (*continued*). 3. Mabel "keeps her face turned away," "maintains one foot in continuous motion," "confines her remarks to 'U-huh.' "	(b) Leans against the picket fence. (c) Experiences "exquisite moments;" "heart beating in an unaccustomed manner;" "suffering from embarrassment." (d) Continues talking although his "usual habits of talking are interfered with, due to presence of unusual feelings," etc.
1, 2, 3 (*continued*). 4. Unusual feelings in stomach, heart, lungs, etc. 5. Continues talking.	(e) Further arousal of sex instinct.
1, 2, 3, 4, 5 (*continued*). 6. Penrod's, "Sam-my and May-bul! Oh, oh!"	(f) Starts violently, blushes. (g) Looks for Penrod.

Finish the analysis of this passage. Be sure to write out your analysis, since by so doing you are forced to think definitely and clearly.[1]

[1] From author's *Psychology of Selling Life Insurance*, 1922, p. 63ff.

LESSON 3

COMPONENTS OF BEHAVIOR (continued)

In Lesson 2, we found that all the details in any lesson may be divided under the two heads, situation and response. Just to strengthen our grasp on this fact let us prove it in another case. We will take the method of teaching reading as given in Lesson 2, and consider not the behavior of a single person but the general principles underlying the behavior of all learners.

Since language is the *sine qua non* of reading we may say that the earliest steps in such learning are taken before the child's first birthday. A probable situation is the entrance of the father and the mother's statement, "Here comes dadda." If the baby happens to make a noise immediately thereupon, which approximates in any way the word "dadda," it will be greeted with wild enthusiasm by the parents, which will arouse the interest and pleasure of the baby. All of the baby's accidental successes will be so delightfully welcomed; his inopportune remarks ignored. After many such occurrences, the presence of the father and the sound of the word "dadda" will practically always cause the baby to say "dadda." After still more practice the sight of the father will in itself be sufficient to cause the baby to call him by name. For the situation has become linked to its appropriate response in the baby's mind.

Many words are learned in like manner. The vocal organs are increasingly exercised by crying, cooing, laughing and chance expressions, until the child has gained the ability to make all the sounds in the language. After this the vocabulary grows rapidly and names can be repeated after one or two hearings.

In all cases we have first the presence of the object and the sound of the name calling up the pronunciation of the name. After this is acquired the mere presence of the object is sufficient to induce the response of the word. Later the physical presence of the object is unnecessary. The ability to express ideas, desires, etc., develops.

Before the child begins to read, then, it has already learned that spoken words stand for visible objects. He has now to learn that visible words stand for spoken words, that there can be two situations leading to the same response.

The object, a flag	equals spoken "flag."
The word "flag"	equals spoken "flag."

The ability to pronounce the word when one sees it in written form is fundamentally the ability to read. (Of course, the reading of a well-trained person involves much more than pronouncing one word at a time in response to its written form. Smooth reading with expression is due to the development of these fundamental processes so that they operate smoothly and automatically together with the development of other habits dealing with expression and the like.)

What the teacher must do then is to form a connection, or *bond*, between this situation (the word "flag") and the desired response (saying "flag"). This is what she does in the method outlined in Lesson 2, i. e.,

1. Writes sentences on board.
2. Asks for recognition.
3. Demands recall.

This, it is clear, on a little consideration is the wise course of procedure. For at first the child has no response at all to the written words, "We have a big flag." The white chalk marks on the board mean nothing to the child. They mean, indeed, much less to the child than Chinese symbols do to you, the reader, for the child does not even know that they stand for spoken words—for objects and actions. But the teacher writes the words, "We have a big flag" on the board and pronounces the sentence to the class. Thus a weak link is formed between the sight of the whole sentence and its sound.

Then the child is asked to pick the sentence out from others. This is not so difficult as recalling it would be. We all know it is easier to recognize a face as having been seen before than to give the name belonging to the face. Even a faint connection between situation and response will lead to recognition.

And, of course, every such recognition strengthens the connection. After some drill the teacher can successfully ask what would have been useless before, that is, that the child recall

what a given sentence says; i. e., respond to the question, "What does this say?" pointing at the same time to the written sentence. With recall the last step is reached and only more drill is needed. Then the child can read.

Reading is then at bottom, the moving of the muscles of the throat in response to certain curlicues on a page or blackboard. The proper control of these muscles is learned before school age. The joining them up with the new situation, the curlicues, is the task of the teacher of reading.

The object of a school lesson seems then to be the formation of a *bond* between a given situation and a desired response. An approved primary method is so constituted that it leads naturally from a stage in which there is no bond, through a stage where there is a slight bond, finally to a stage where a fairly strong bond is established and made stronger by drill.

Situation, Bond, and Response

Just how a human being behaves depends upon two factors—upon the elements confronting him in his environment and upon his own internal make-up. If we know what these external elements are and what the internal organization of the individual is, we can prophesy what he will do in response to any particular situation. For example, we know that all educated people can add and spell; consequently, we can safely depend upon it that any educated Englishman or American will think "four," and then "cat," as he reads the next line:

$2 + 2 =$ c-a-t

In the same way we know, if a boy and girl are interested in each other, that when they meet they will show embarrassment, excitement, etc. If they don't show these evidences of emotion they are not interested in each other. And we all know that a boy gets angry when called names, or caught with a girl he likes, or interfered with when he is with that girl. Knowing these things, we can prophesy a fight when Penrod provokes Sam.

There is absolutely nothing profound or complicated in this psychological analysis. We all know these facts and to a very considerable extent act upon them. For example, what happens when a circle of girls suspect one of their number of being engaged? They suddenly confront her with situations that should

make her blush or show embarrassment if she is engaged. And they determine whether she is guilty or not, not by what she says, but by the tone of her voice and her manner. For words we can fairly easily control, but not the tone of voice or manner.

Analysis of Behavior.—Suppose that without noticing what I am doing I put my hand on a hot radiator. The next moment I jerk it off, of course. Here we have the simplest kind of behavior. The hot radiator stimulated nerve endings in the skin of my hand, nervous current flowed over the sensory nerve to the spinal cord, from there it was directed out over motor nerves to the muscles of my arm, they contracted and jerked my hand away. All this would happen in just the same way were I asleep or awake; in other words consciousness is not involved. Later on I may be conscious or not, depending upon circumstances. The elements involved in all this are:

1. Hot radiator in contact with skin.
2. Sense-organs (nerve-endings) in skin aroused by heat.
3. Nerve current to nerve center.
4. Nerve current through nerve center.
5. Nerve current from nerve center to muscles.
6. Contraction of muscles (hand pulled away).

Before attempting to see what this means, consider a second example of behavior. Upon seeing "2 + 2 = " I instantly think "4." Here the following elements are involved:

1. "2 + 2 = "
2. Sense organ of sight (eye) stimulated.
3. Nervous current from retina of eye to brain.
4. Nervous current through brain (nerve-centers).
5. Nervous current from brain to muscles.
6. Contraction of muscles in throat (for when I think "4" the muscles of the throat move).

In addition there is:

7. Consciousness of (*a*) seeing "2 + 2 = " and (*b*) thinking "4." (No one knows what relationship exists between "7. Consciousness" and "4. Nervous current through brain nerve-centers," but apparently consciousness is present only when such nerve-centers are aroused.

Analysis of one more example of behavior, which is slightly more complicated, will aid in making our point clear. John is asked by his teacher "If you had a quarter and bought four apples

at four cents each, how much money would you have left?" Here the elements are:

1. Problem presented by teacher to John in school.
2. Sense-organs of hearing and sight stimulated.
3. Nervous current to brain.
4. Nervous current through brain.
5. Nervous current from brain to muscles.
6. Contraction of muscles, saying "nine cents."
7. Consciousness of:
   (*a*) being in school, in arithmetic class, of being called upon by teacher, etc.
   (*b*) problem.
   (*c*) thinking 4×4.
   (*d*) thinking 16.
   (*e*) thinking $25 - 16$.
   (*f*) thinking 9.

Here we have quite a complicated lot of factors. They could be made to appear still more complicated if they were subdivided into still finer divisions.

One Way of Grouping Elements.—These elements can be grouped roughly under the three headings of situation, bond, and response, so that all the elements that affect the individual are put under the heading of situation; all the elements that are involved in the result are put under the heading of response; and the connection between situation and response is classed as bond. When so grouped we should have:

Situation	Bond	Response
1. Problem, etc. 2. Sense-organ aroused. 3. Nervous current to brain. 7. Consciousness of: (*a*) being in school, etc. (*b*) problem.	4. Nervous current through brain.	5. Nervous current to muscles. 6. Muscular contractions. 7. Consciousness of: (*e–f*) thinking out solution.

The *situation* will always be used in the practical sense of including (*a*) objects arousing sense-organs to activity, and (*b*) presence[1] of all other elements in mind at the time. For example,

[1] Strictly speaking, the very general term "presence" must be used and not "consciousness" because one responds to elements that are present but not necessarily conscious, as, for example, restlessness and listlessness as responses to a slight fever not consciously realized.

in the story of Penrod and Sam, Mabel is an object which stimulates Sam's eye, he becomes conscious of her, and at the same time is conscious of his interest in her. All these together cause him to stop and talk to her.

The response will always be used in the practical sense of including (*a*) muscular movements, (*b*) change in activity of glands (e. g., flow of saliva upon seeing a well-cooked beefsteak) and other physiological changes within the body (e. g., heart beating faster) and (*c*) consciousness of result from responding to situation (e. g., answer to problem, satisfaction at getting it correct, etc.).

The bond will always refer to the connection between situation and response—a connection to be thought of as a pathway made up of nerve-cells and a pathway over which current passes when the situation occurs.

Situations are Ordinarily Complex.—When you read "2 + 2 = " you are confronted with a very simple situation. But when Sam replied to Mabel by saying, "Well, Mabel, it ain't my fault. I didn't do anything. It's Penrod," he was responding to a very complex situation. It involved his love for Mabel, her presence, his unnatural feelings and emotions, the presence of Penrod, Penrod's remarks, Mabel's reactions to Penrod shown in her remarks to Sam and her walking away. But these were only a beginning. Such other factors were involved as, Sam's being born a boy, a certain number of years before, with definite hereditary tendencies; his having grown up in a rough-and-ready boy society. Eliminate any one of these elements of the total situation confronting Sam and his response would be different.

Can an item be both a response and a situation?—The analysis of the passage from *Penrod and Sam* has undoubtedly puzzled many, in that certain items were listed in one "scene" as responses and then in the next "scene" as situations. For example, one response on the part of Sam on meeting Mabel was "exquisite moments," "heart beating in an unaccustomed manner," "suffering from embarrassment." These phenomena resulted from meeting her. But they in turn immediately commenced to affect his further behavior. Thus the wildly beating heart and irregular breathing interfered with his talking. In the same way the response of thinking out the answer "nine cents" to the problem analyzed above can be broken up into scenes

to show that as each element in the response occurs it immediately joins with all the other elements in the situation to cause the next response.

Behavior is a steady stream of events. In analyzing it we have to break it up into short scenes in order to discuss it. In doing so we do violence to some of the facts. But if we bear in mind that the scenes are artificial units of behavior, that behavior is flowing along, and that details from without first make some impression and then very often these responses in turn join with the next details from without as causes for the next impression, we shall not go far astray in our study.

A Second Way of Grouping Elements Entering into Behavior.—At times it is very helpful for clear thinking to distinguish between the object in the situation and the conscious elements present in the mind at the time. The term "*stimulus*" (plural stimuli) will accordingly be used to refer solely to the external object stimulating a sense-organ.

There is no corresponding term which covers the muscular and glandular response to stimulation and does not include the conscious elements of response. But when the formula stimulus-bond-response is employed, the term response should be interpreted in the narrower sense, whereas when the formula situation-bond-response is used, the term response should be interpreted in the broader sense.

This double way of dividing behavior into its components is very troublesome to beginning students in psychology. As the course progresses the matter will gradually become clearer and clearer; particularly so, if the student will keep clearly in mind that when situation-bond-response occurs the emphasis is being put upon cause and effect, whereas when stimulus-bond-response occurs, emphasis is being put strictly upon the factors outside the individual as they affect him. And in such cases the elements within his brain are to be thought of as due to systems of nerve-cells that have been aroused to activity—hence are to be viewed as part of the bond.

Further Consideration of the Term "Bond."—The term "bond" conveys the meaning of *connecting* situation and response. Instead of "bond" the term "mechanism" could be employed, so calling to mind a *system of nerve cells that operates as a unit.* And again, instead of "bond" the term "experience" could be

used, thus emphasizing that the individual is acting in terms of his own *experience*, or that of the race, born in him. When "bond" is used all three of these conceptions should be thought of. The response follows the situation because a mechanism has been set into operation connecting the two together and this connection represents the experience of the past.

Scientific Conception of Behavior

The teacher (and most of us do more or less teaching during our lives) needs to realize that his task is to so present stimuli that a situation will confront the child which will lead to the desired response. This means the teacher must acquire a fund of knowledge and experience so as to know the psychological connections between situations and responses. Such knowledge will help in two ways: first, it will enable the teacher to present the right stimuli and second, it will cause the teacher immediately to look for the presence of unsuspected elements in a situation when the desired response does not result. For example, a boy was transferred from one school to another and at the bottom of the transfer was written, "George is a good boy and gets his lessons well." The new teacher stuck the transfer on a hook on the wall where it was seen by the children in the room. George had been a good boy in the sixth grade, but no situation that the seventh grade teacher could devise would cause good behavior because he was always reacting to the jibes of his fellows about being a good boy. Lack of knowledge of how a twelve-year-old boy must respond to the situation "good boy" from his playmates caused this teacher a "heap" of unnecessary trouble.

Summary

Two principal points have been presented so far. First, the nature of psychology and what psychologists are attempting to do, and second, that behavior can be viewed in terms of the three components—situation, bond, and response.

Object of Lessons 4 to 18

In the next fifteen lessons an analytical study of the learning process will be made. Very simple tasks of learning will be assigned and careful observations of how each task is accom-

plished will make many of the fundamental principles of learning apparent.

The next class-hour will be devoted to such an experiment. Before coming to class, read over the instructions in Lesson 4 up to the heading: "Instructions for writing up the results." *But do not practice the experiment.* If you do, you are quite likely to get results at the next class-hour that will be misleading and extremely difficult to write up.

LESSON 4

HOW DOES ONE LEARN TO SAY THE ALPHABET?

The first laboratory assignment in a new course of study must necessarily be very simple, else the beginning student will be swamped with all the details confronting him. Consequently, we shall study here what is apparently a simple problem, i. e., the processes involved in learning the alphabet—particularly in learning to say it backwards. But although the assignment in one sense is very simple, yet in another sense it is most profound. No one can list all the processes that are involved here nor understand any of them absolutely.

The student commencing this course should carry with him much of the spirit of the early pioneer. He is starting on a journey of exploration in which some of the landmarks are known and mapped for him but most of the smaller points of interest are not mapped and still remain to be discovered. This course in educational psychology will afford every student opportunities for discovering facts and principles regarding the learning process not now recorded in any textbook. Consequently he may attack this seemingly trivial assignment in the spirit of exploration and with the determination to discover new things.

1. Problem.—What happens when you recite (1) the alphabet forwards twenty times, and (2) the alphabet backwards twenty times?

2. Apparatus.—A watch with a second hand. (If you do not have such a watch, obtain one from the instructor.)

3. Procedure.—Two persons will work together; one will be the *Subject* (person to do the reciting) and one will be the *Experimenter*. When both are ready the Experimenter will watch the second hand and when it reaches 58 on the dial will call out, "Get ready," and when it reaches 60 will say "Go." The Subject will then recite the alphabet as fast as possible. When the Subject reaches the letter "Z" the Experimenter notes the number of seconds that have elapsed and records it in his notes.

The Experimenter will find it necessary to have before him the alphabet written out so that as the Subject recites he may follow with his eye and note any mistakes in the Subject's recitation.

After each of the 20 trials, the Experimenter should record (*a*) the time required by the Subject to recite the alphabet, (*b*) any mistakes in doing so, (*c*) any changes in method he may note, (*d*) any other interesting facts.

Having finished the above, repeat the whole procedure but this time recite the alphabet backwards, instead of forwards. The Experimenter should write out the alphabet backwards in order to aid him in catching the mistakes of the Subject. The Experimenter will not prompt the Subject except to say, "No," when the Subject gives a wrong letter.

As before, the Experimenter will record (*a*) the time required by the Subject to recite the alphabet backwards, (*b*) any mistakes in doing so, (*c*) any changes in method, (*d*) any other interesting facts.

(Finish the above before reading further.)

Instructions for Writing up the Experiment

If possible both partners should arrange to prepare the assignment together. If this is not possible, then the Subject should secure a copy of the Experimenter's notes. Both should prepare this assignment and hand it in at the next class-hour.

How to Plot a Learning Curve.—Refer to the curves shown in Plate I, as a model. The curves of no two persons are alike, consequently yours will not agree exactly with the two given in Lesson 1.

Plot the data you have secured in the two parts of the experiment. Do as follows: Secure a sheet of co-ordinate paper. Draw a line across the bottom of the sheet about a half inch from the bottom. Draw another line at right angles to this base line along the left-hand side of the sheet, about a half inch from the edge of the paper. At intervals of about one-fourth inch number consecutively from 1 to 20 underneath the base line. Number the lines along the vertical line consecutively from 1 up as far as the paper permits. Call the base line "0."

The numbering along the base line represents the successive trials from 1 to 20. The numbering along the vertical axis

represents the amount of time consumed in reciting the alphabet. Hence at the right of the figure 20 write the word "Trials" and at the top of the page above the last number in the vertical scale, write the word "Seconds."

When this is done, note the time-record in the first recitation of the alphabet. Suppose this is 6 seconds. Now mark a small "x" at the intersection of the line numbered "6 seconds" and the line numbered "trial 1." Suppose the second trial was done in 5 seconds. Then mark similarly a small "x" at the intersection of the 5-second line and the 2d-trial line. (If it was 5½ seconds, instead of 5, the cross would be made half-way between the 6-second and the 5-second line.) When you have marked the twenty "x's," then connect them together withs traight lines. This jagged line represents the *learning curve* in saying the alphabet forwards. Draw the learning curve for saying the alphabet backwards in the same way.

Give a *title to the sheet*, such as "Learning Curves for Reciting the Alphabet Forwards and Backwards."

How to Write up the Experiment.—1. *The problem.*—State what is the problem you are attempting to solve. In this case the problem may be stated as "How Does One Learn to Say the Alphabet?"

2. *Apparatus.*—State under this heading what apparatus you used in solving the problem, as "A watch with a second hand."

3. *Procedure.*—State what you did in order to secure your results. Give date and names of the Experimenter and Subject, first of all. In this course you need not copy the procedure as given in the text but may state, "Followed instructions as given in manual, except ——." Then give in detail any deviations.

4. *Results.*—Here record (1) your time records, (2) mistakes made, (3) changes in method, (4) other interesting facts, (5) your curves. In other words, record under this heading the material you have gathered together in performing the experiment.

5. *Interpretation.*—Here ordinarily you would summarize your results and explain what they mean. At the beginning of this course you will be aided in interpreting your results by being given specific questions to answer—questions which help you summarize and explain your results. In this case, answer the following questions:

(*a*) How do your two learning curves differ? Explain why.

(*b*) In what respects do the two curves agree? Explain.

(*c*) Why is it possible to recite the alphabet faster and with fewer mistakes on the twentieth trial than on the first trial? Has the Situation changed? Has the Response changed? Or has the Bond changed?

(*d*) Why do you suppose in Lesson 3, Carl could write the word "leaf" on the board after having seen his teacher write it and not before? What changed there—the situation, the response, or the bond?

6. *Applications.*—Record concrete cases where principles developed here will apply in other phases of life. For example, in learning to use a saw, one will saw through a 6-inch plank very slowly the first time and will do a pretty poor job. Next time the job will be done in less time and with fewer ragged edges. Successive trials will result in better and better work. The greatest progress will be made in the early trials.

In this lesson you have been confronted with several things, which were probably new to you, such as:—

1. Saying the alphabet backwards.
2. A learning curve and its characteristics.
3. Plotting a curve.
4. Writing up a laboratory experiment according to a prescribed outline.

It will require a number of further lessons before the last three of these propositions will become thoroughly established. Apply what you have learned in this experiment to yourself. It will take time to write up this experiment and you will not do it without many mistakes. A month from now you will have cut your time in half and you will not make those mistakes. Do the best you can in the time you have for preparing the lesson.

LESSON 5

SOME FACTS CONCERNING THE LEARNING PROCESS AS OBTAINED FROM THE ALPHABET EXPERIMENT

All learning is dependent upon practice, upon performing what is to be learned. That is the way you originally learned to say the alphabet forwards and that is the only way you can learn to say it backwards.

In like manner you must yourself work out the assignments of the course. And to the extent that you do actually answer the questions, to just that extent you have a real grasp of the contents of the course.

In order to afford you a check upon your work so that you may know how well you are doing it, the odd-numbered lessons (e. g., lessons 5, 7, 9, etc.) will answer the problems raised in the even-numbered lessons (e. g., lessons 4, 6, 8, etc.). These answers are not complete answers; no one knows enough today to answer absolutely completely. But they will furnish sufficiently complete answers for the purpose of the course.

It goes without saying that you will lose the full value of the course if you refer to the odd-numbered lessons before handing in your written reports upon the corresponding even-numbered lessons.

ANSWERS TO QUESTIONS IN LESSON 4

How Do Your Two Learning Curves Differ? Explain Why.—(1) The "saying alphabet forwards" curve drops very little, whereas the other curve drops a great deal. That is, there is very little improvement in the first case and a great deal in the second.

2. The curve in the first case is practically a straight line (disregarding now the irregular fluctuations) while the curve in the second case shows a very great drop at first with less and less of a drop as the trials continue.

3. The second curve is throughout "higher" than the first curve.

Explanation. The learning curve of a performance that

has not been practised, shows a big drop after each trial, but as the trials continue, the curve drops less and less until it finally reaches a certain limit. In the case of saying the alphabet forwards we must realize that the early trials (with their resulting big drops) have occurred long ago. We are dealing possibly with trials 1001 to 1020 and can expect only very slight improvement from trial to trial. In fact we must be fairly near the limit of speed that can be obtained in this performance.

The chief difference between the two curves is to be explained by the fact that the first curve is the only portion we have of a learning curve made up of, say, a thousand and twenty repetitions, whereas the second curve is actually representative of the beginning of a learning process. The first curve must needs be nearly a straight line with only a slight drop, while the second curve must needs show large drops between each successive trial, but smaller and smaller drops as the repetitions continue. If we kept up the reciting of the alphabet backwards 10 times a day for a month or more possibly we would then get a curve on the last day that would be similar to our first curve.

From the shape of the curve we can then tell something as to the amount of training which has already preceded the first trial shown in the curve.

In What Respects Do the Two Curves Agree? Explain.—(1) Both drop. Both show improvement in the work done.

Explanation. A fundamental law of human behavior is the only explanation that can be given for the fact that both curves drop. Continued repetition of a performance results in that performance becoming easier and easier and when there is any effort made to decrease the time of doing it, the performance is done in less and less time.

2. Both show fluctuations. Improvement is not always shown between successive trials. Sometimes the performance is much inferior to that of several preceding trials.

Explanation. The performance of any act is made up of many parts. Learning the whole performance (e. g., saying the alphabet backwards) consists in learning to do each little part and in learning to do them in the correct order. Sometimes the parts are all fairly well done—then we make a better record than usual—there is a sudden drop in the curve. Sometimes the parts are done poorly—then we make a poorer record than

usual—there is an upward shoot to the curve. Most of the time we do some parts well and some poorly—then we make an average record.

The causes as to why any part is done poorly or well will be taken up later. (Commence watching for them. Note why you fumble in tying your shoes, putting on your hat, shaving, spreading butter on a slice of bread, misspelling a word, answering a question incorrectly in an examination, etc.)

In What Respects Do the Situations and Responses Differ at the Beginning and End of the Two Experiments? Explain Why.—(This question is inserted in addition to those asked in Lesson 4.)

As to situation.

1. Certain details were added to the situation. Certain details affected the Subject more and more, e. g.—
   (*a*) Certain combinations of letters are difficult (e. g., w, v, u, t.) and so are watched with more than ordinary care.
   (*b*) Letters said at first more or less one at a time, later become grouped—groups thus take the place of single letters as the items which affect the subject.
   (*c*) The ideas, "I must go fast," "I must not make mistakes," impress the subject more and more.
2. Certain details were eliminated more or less from the situation, e. g.—
   (*a*) Strangeness of surroundings ceased to affect the Subject.
   (*b*) Strangeness of requirement—to recite alphabet in psychology class—was forgotten.
   (*c*) Presence of other individuals, their conversation, etc. became less noticeable.
   (*d*) Presence of the Experimenter, the fact that he was watching, the fact that he was taking notes, the fact that he was timing, etc., had less effect.

In other words, as learning progressed, the situation actually changed. Certain details affected the Subject more and more and certain other details less and less.

As to response

1. Actual performance was done (*a*) more quickly, (*b*) with fewer mistakes, (*c*) more smoothly.

2. Feelings of strangeness, unfamiliarity, nervousness, excitement, unpleasantness, etc., became changed more or less to feelings of familiarity, confidence and pleasantness, etc.
3. Actual method of doing work was changed, particularly in saying alphabet backwards, e. g.—
   (*a*) At first alphabet had to be recited forwards in order to say it backwards; later this became unnecessary.
   (*b*) It was recited in short pieces with pauses in between.
   (*c*) Pauses became shorter, groupings of letters longer and longer.
   (*d*) Etc.

The process of learning involves then not simply doing work faster and faster with fewer and fewer mistakes, but also attention to different details in the situation coupled with qualitative changes in method (The above changes in both situations and response are actually due very largely to changes in the bond. From practice there results a better and better co-ordination and functioning of neural path-ways and the elimination of other path-ways that interfere with the work in hand. As explained in Lesson 3, these changes can be referred, however, to the situation or response.)

Why is it possible to recite the alphabet faster and with fewer mistakes on the twentieth trial than on the first trial? Has the situation changed? Has the response changed? Or has the bond changed?

The first part of this question has been answered under the second question, above.

Has the situation changed? In one sense, No. There are the same factors outside the learner at the twentieth trial that were there at the first trial. But in another sense, Yes. In some way or other the learner has changed, so that he is influenced less by certain of the outside factors and more by other outside factors. Actually from the standpoint of the learner, then, the situation has changed, he is affected by details in a different way from what he was at the start.

Has the response changed? Undoubtedly. This is shown by the decrease in time and the increase in accuracy, also by the change in attitude toward the task.

What other changes have there been? We shall come to see

that the bond or mechanism within the learner that is affected by outside factors and that controls the learner's muscles (for all behavior is composed of muscular movements) has been changed by the repetition of the alphabet.

We may think of this nervous mechanism as having been changed, on the one hand, so that now in this particular situation it is more susceptible to certain details and less susceptible to other details, and on the other hand, that it controls and directs the muscles engaged in speaking differently from what it did at the start. The learner is certainly more susceptible to the difficulties of reciting "w, v, u, t" than at the start. He is also less concerned with the presence of his partner than at the start, and undoubtedly does recite the alphabet backwards in a much better manner than at the start. His behavior is different. His response to the situation is different.

Learning to say the alphabet backwards comprises a certain situation, a certain response and a bond between the two. At the start this bond is very imperfectly developed. As repetition continues, the bond is developed until finally the situation (Experimenter says, "recite the alphabet backwards") is adequately bound to the various muscular movements which cause the letters of the alphabet to be sounded.

Let us look upon the multiplication table in this same way. The teacher asks, "What is 6 times 8?" The child responds "48." The situation, in terms of the child, is (1) the teacher, (2) the sounds making up "What is 6 times 8?" Certain muscles in the throat and mouth move and the child has said "48." Connecting the ear and the throat muscles are various nerve-centers and nerve-fibres. The stimulation in the ear has been communicated in a wonderful way over these nerve-pathways to the muscles in the throat and they have been moved—and "48" is said. The terms, "Situation," "Bond," and "Response," may be thought of now as covering this whole learned performance.

Why do you suppose Carl in Lesson 2 could write the word "leaf" on the board after seeing his teacher write it and not before? What changed there—the situation, the response or the bond?

If Carl has learned to write the word without knowing his letters, then the sight of the word and sound of the word have

both become bound up with the movements of making the word. While Carl looked at the word and while he listened to the sound of the word, he wrote the word in the air, i. e., made the movements necessary to write the word. Diagrammatically, we have

Sight of word ——→ Movements involved in writing word.
Sound of word ——→ Movements involved in writing word.

Through previous training in school and outside Carl had learned how to trace a drawing. Hence when he saw the word he was able to trace the word in the air. After a sufficient number of repetitions the bond connecting this situation with this response became strong enough to function. But the possession of a bond between *seeing* the word "leaf" and writing it was not enough, else Carl could not write the word when his teacher *pronounced* it. While Carl was looking at the word he was also muttering it to himself. The teacher was also pronouncing it. Hearing the word then was part of the situation. And while hearing it he was also writing it in the air. Repetition of this detail of the situation and the response shortly resulted in a bond being formed between hearing the word and writing it.

To answer the question, we must reply that a bond was formed between sight of the word "leaf" and the movements necessary to write it, also a bond between hearing the word and writing it. There has been a development of new bonds and consequently a new response. Before there was no bond and hence no writing response to the word "leaf." Afterwards there is a bond and so an appropriate response is possible.

It should be borne in mind that the above analysis is not so full as it should be. And it should further be borne in mind that this analysis may be true of some children and not true of others. We do not know today just how all children come to do these things. Some details will be added as this course develops.

Summary of Points Covered So Far in This Course

1. Analysis of sight-spelling lesson.
2. Understanding of the terms, "Situation," "Bond," and "Response."
3. Realization that a situation is a complex affair made up of many details and a response is correspondingly complex.
4. Method of plotting a learning curve.
5. The fact that repetition of the same performance produces

changes in the real situation, in the response, and in the bonds connecting situation with response.

6. Some characteristics of learning curves.
7. A method of writing up a laboratory exercise, involving the classification of your material under six headings:—
   (*a*) The Problem, what you are trying to do.
   (*b*) The Apparatus, what you have to work with.
   (*c*) The Procedure, how you go at solving the problem.
   (*d*) The Results, what information you discover.
   (*e*) The Interpretation, what you decide the results mean.
   (*f*) The Application, how the general principles outlined under "Interpretation" can be applied to other problems.

Some Information Concerning the Construction of Curves

1. All learning curves are based on two columns of data. The first column indicates the successive trials or successive units of time in terms of which the progress of learning is measured. The second column gives the measurements of the learning. For example, the data on which Curve B in Plate I is based are as follows:

Trials	Number of Seconds Required to Recite the Alphabet Backwards
1	46.0
2	30.1
3	28.4
4	27.8
5	25.1
6	22.9
7	21.0
8	21.8
9	21.2
10	20.1
11	20.2
12	16.9
13	18.2
14	16.0
15	15.3
16	15.6
17	13.6
18	13.9
19	15.5
20	12.5

2. The trials are indicated along the horizontal axis and the "measurements of the learning" along the vertical axis.

3. Figures for the horizontal scale should always be placed at the bottom of the chart and the figures for the vertical scale at the left. Make clear what the scales mean.

4. In the curves in the psychological field, the horizontal scale should read from left to right and the vertical scale from bottom to top.

5. All lettering and all figures on a chart should be placed so as to be read from the base or from the right-hand edge of the chart.

6. Points on the curve should be indicated with little crosses (x) and connected with a line that is heavier than the co-ordinate ruling so that the curves may be clearly distinguished from the background.

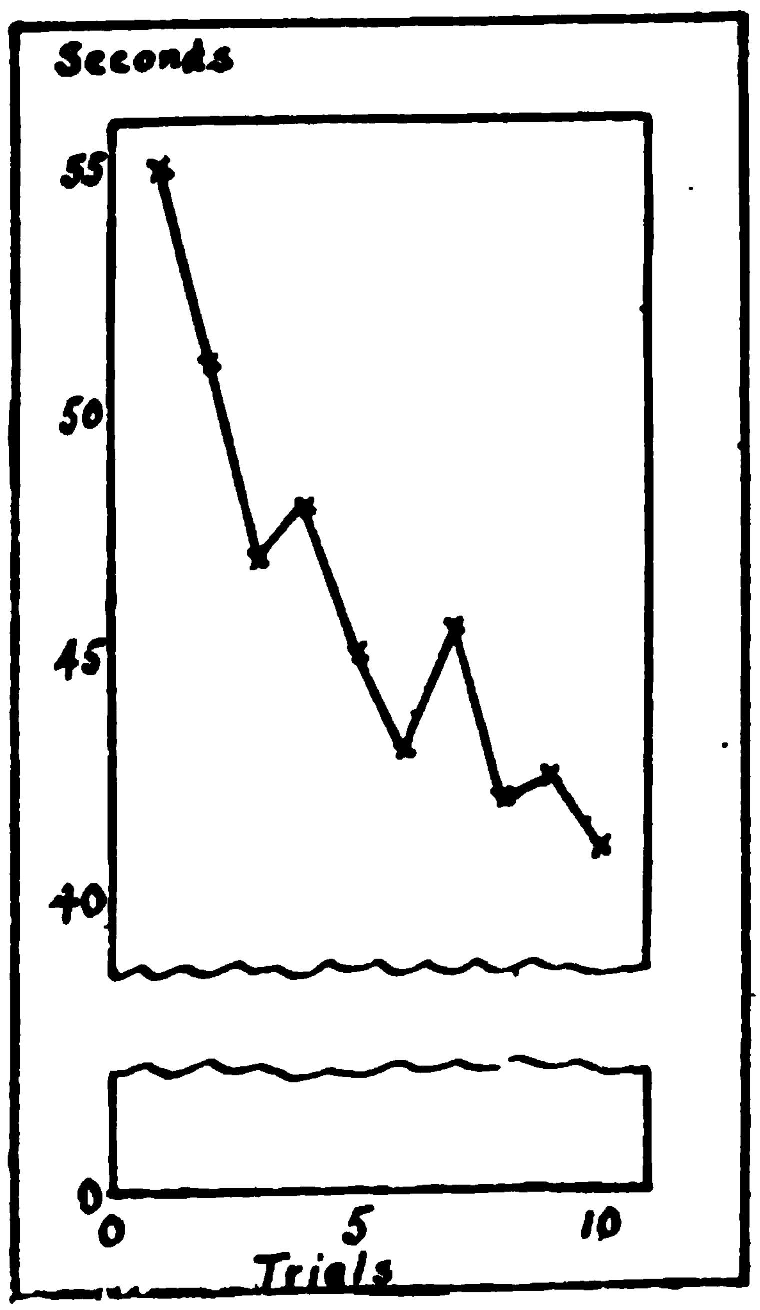


PLATE II.—Model graph, showing how zero base line should be indicated when there would not otherwise be space available to include the base line.

7. Only in exceptional cases should the zero line of the scale be omitted. If it would require too much space to include the zero base line, the bottom should be a slightly wavy line indicating that the field has been broken off and does not reach to zero. This is shown in the accompanying graph, Plate II.

8. The title of a chart should be so complete and so clear that misinterpretation will be impossible. In fact, the ideal is to write so definitely that if a stranger picked up the chart he could understand what it meant.[1]

[1] Good references on this subject for those interested in the subject are: W. C. Brinton, *Graphic Methods for Presenting Facts*, 1914 and C. Alexander, *School Statistics and Publicity*, 1919.

LESSON 6

HOW DOES ONE IMPROVE IN MIRROR-DRAWING?

In Lessons 4 and 5 we obtained some idea of the process by which one learns an alphabet. The same general principles will apply more or less to the learning of lists of things, such as conjugations, declensions, etc.

Today we are interested in discovering the general characteristics of the learning process in such cases as learning to write with a pen, to ride a bicycle, to skate, to use a saw, etc. As adults are all able to write it is manifestly impossible to study with adult subjects the learning processes involved in handwriting. For that reason the experiment will be devoted to learning to draw while looking in a mirror. This process involves many factors which are common to learning handwriting. Endeavor as best you can to understand this learning process as it will help you to understand what a child experiences while learning.

As before, one partner will act as Experimenter (E) and the other as Subject (S). Here the emphasis will be upon completing the drawing of 17 stars in the mirror-drawing apparatus. This can only be done by prompt and efficient effort.

The Mirror-Drawing Experiment

Problem.—How does one improve as one learns to draw in the Mirror-Drawing apparatus?

Apparatus.—Mirror-Drawing Outfit; 17 six-pointed star blanks, watch.

Procedure.—1. The Experimenter determines how long it takes the Subject to trace the outline of the star, *without using the mirror*. Let him start at the point marked in the star and draw naturally around within the two lines.

2. Experimenter arranges the apparatus so that Subject can

not see his own hand directly, but only through the mirror. Subject is to trace the outline of the star as quickly as possible with a lead pencil.

The requirement is that the pencil *must stay on the paper*, and must pass in order around the star. Measure the time required to pass around the star. Then record the number of times the pencil line touches either of the two printed lines. Each one should be counted a mistake. Furthermore, when the pencil is outside of the two printed lines, each change in direction should also be counted as one mistake.

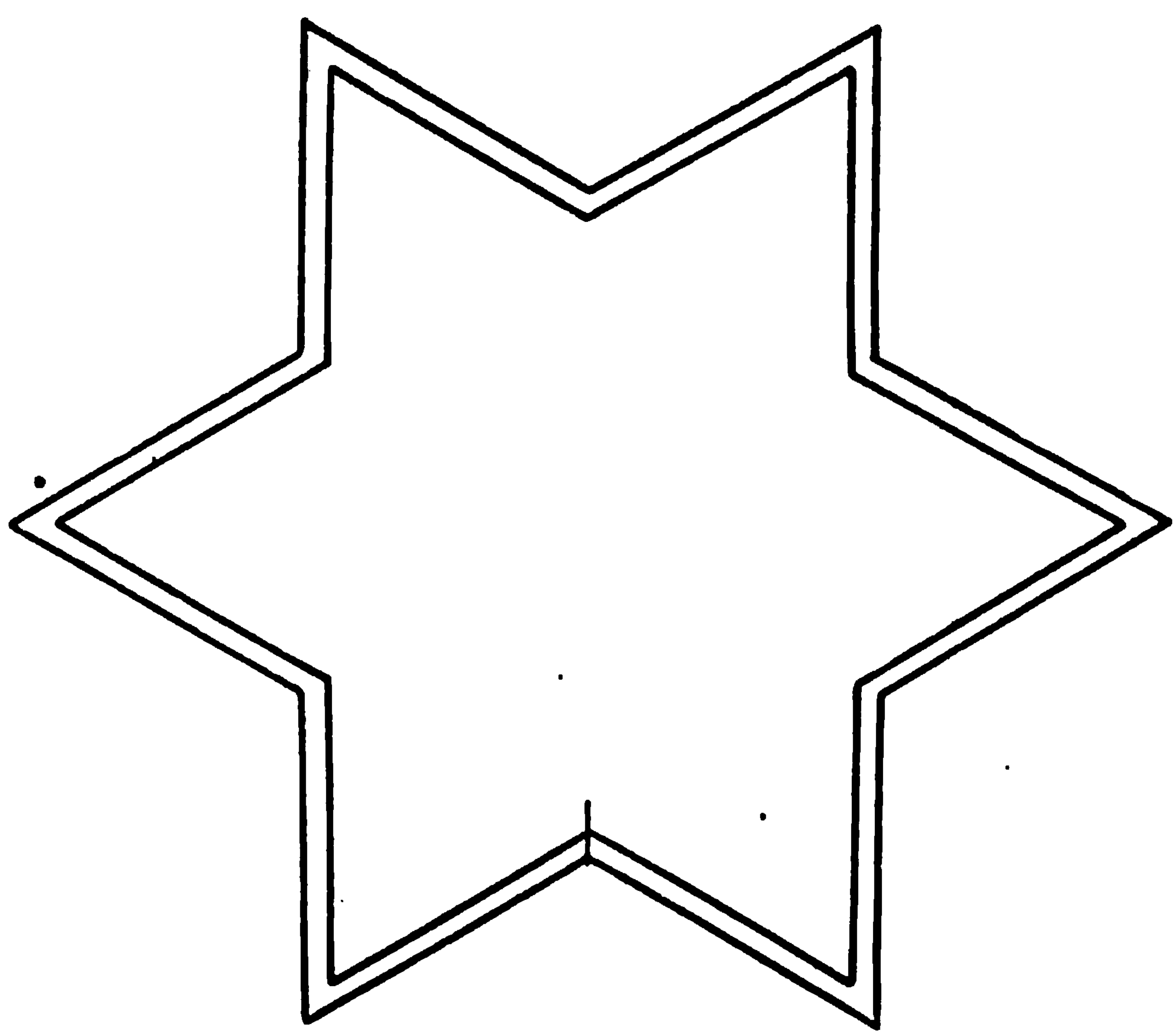


PLATE III.—Star blank for mirror-drawing experiment. (Actual size 4¼ × 5 inches.)

The star should be so placed that the starting point is towards S as he sees it in the mirror. If now each point is numbered from 1 to 12 (12 being at the starting and ending point and 1 at the point to S's right as he sees it in the mirror), it will be found to make the matter of writing up the laboratory notes much easier, for all places on the star can thus be easily referred to.

3. Have S trace 14 more stars in the mirror-drawing apparatus, making a total of 15 in all. Obtain the time for each trial.

Be sure to write on each star blank the number of the trial and the name of the Subject, also the time consumed in doing the drawing. Otherwise a gust of wind may mix up your papers and ruin your experiment.

4. Have S trace another star as he did in (1) without the use of the mirror.

This provides for the use of 17 star blanks; 2 are used without the mirror and 15 with the mirror.

Results.—E should have recorded then, (1) the time of each performance, and (2) the number of false moves to be observed by counting the number of times the lead pencil touches or crosses a printed line, and the changes in direction when without the printed line.

The learning curves. Plot both the time-records and the accuracy-records. Provide on the base line space for 17 trials; on the vertical axis space for recording up to 300 seconds. (You can do this by letting each horizontal line represent 5 or 10 seconds.) Remember trials 1 and 17 were made without the mirror; trials 2 to 16, with the mirror. Do not connect trial 1 with 2 or 16 with 17. Connect trial 2 with 3 with 4, etc., up to 16, using a solid line; and trial 1 with 17 using a dotted line.

Next plot the accuracy-records. For the sake of convenience consider each error equivalent to a second in time and plot accordingly. Finally plot a third curve obtained by adding together the seconds taken to do the trials with the number of errors. This curve will represent the course of learning, taking into account both time and accuracy combined.

Both partners will write up the report according to the outline given in Lesson 4. The *Results* will include the material (*data*) gathered together during the experiment and also the three learning curves.

Interpretation.—Under this heading note answers to the following questions:

1. What changes take place when the same performance is repeated a number of times? Consider (*a*) speed, (*b*) accuracy, and (*c*) the two combined.

2. What light do the data secured when the mirror is not used throw upon the main results of this experiment? In other words, how efficiently do you suppose the Subject could come to do the mirror-drawing after a great deal of practice?

Applications.—Do not fail to report some *concrete* examples of how the principles discovered in the experiment can be applied to your own work.

NOTES: (1) The word "data" is plural always.

(2) As you are studying the learning process it is absolutely essential that S shall not practice in any way whatever between trials, else your data will not be complete. If a trial is performed and the time-record is lost, report this fact. For example, if the time-record for the 12th trial was lost, call it nevertheless the 12th trial, and the next trial the 13th. In plotting, simply connect the 11th and 13th records with a dotted line, to indicate that the 12th record is missing.

LESSON 7

GENERAL CHARACTERISTICS OF THE LEARNING PROCESS

Answers to the Questions in Lesson 6

What changes take place when the same performance is repeated a number of times? Consider (a) speed, (b) accuracy, and (c) the two combined.

The first drawing with the right hand in the mirror was done very slowly and with many mistakes. The second drawing was very much better, there being a noticeable decrease both in the time consumed and the number of mistakes made. With each subsequent trial there was improvement (barring certain exceptions) until with the last trial we have a drawing made in very much less time and with few errors. In Plate IV we have three learning curves showing 20 trials (not 15) and based on the average of 18 records from men and women. Both curves A (accuracy) and B (speed) show rapid improvement at the start with smaller and smaller gains as the practice continues. The combined curve (C) shows the same peculiarities.

From studying curves B and C it is apparent that if these 18 individuals had continued the practice for more than 20 trials they would have improved still more. Curve A, on the other hand, suggests that they had reached their limit in accuracy; in fact, that they had reached this limit by about the 8th trial. (Trials 12 and 18 are actually the most accurate.) There is, however, another possible explanation. The instruction given the individuals whose average data we have before us, was purposely left indefinite as to whether *speed* or *accuracy* should be striven for. Their reports show, however, that most of them had in mind doing the task as quickly as possible, with a fair degree of accuracy, rather than doing the task as accurately as possible with a fair degree of speed. Consequently, the time curve shows the greater amount of improvement. It

is extremely likely then that the accuracy shown in Curve A from the 8th to 20th trials represents to these individuals "a

PLATE IV.—Curves showing progress of learning to draw while looking in a mirror.

Curve A records errors made per trial. Curve B records time (in seconds) consumed per trial. Curve C records total errors and seconds per trial.

fair degree of accuracy"—that during those trials there was little or no attempt to improve their accuracy. If this be true, further practice would eventually bring each subject to a point

where he would realize that his accuracy-record was not so good as it might be as compared with his time-record. His general attitude toward the work would change then so that he would strive for accuracy in a way that he had not done previously. Following this change in attitude there would undoubtedly appear a series of drops in the accuracy-curve with possibly little or no improvement in the time-curve. Judging then from what we can learn from the observations of our subjects, they have not reached their limit of improvement in accuracy, but rather only a temporary limit, this temporary limit being due to their attitude toward the work.

Such temporary limits are called *plateaus* or level places in a learning curve. In terms of what little we now know from this course about plateaus, we may define them as "temporary limits to improvement." In terms of our three components Situation, Bond, and Response, we may say that certain details in the situation are not affecting the learner as they should. Because they are not, there is little or no response to them and hence no improvement in the bonds connecting those details in the situation with their appropriate details in the response. Later these details commence to affect the learner, the bonds between those details and their responses commence to be used and improvement follows. At least this was apparently the case here. The little irregularities in the drawn line together with various memories which make up our notion of accuracy, all these were not affecting the learner so strongly as they might. As these details were being reacted to only a little or not at all there was little or no chance for the bonds to be developed. Later these same details would commence to affect the learner and then there would come improvement in accuracy. We shall then need to add to our previous conceptions of a learning curve—rapid improvement at first with less and less improvement as time goes on—this notion of a *plateau*. Improvement may cease entirely, certainly as far as objective proof is concerned, for a period of time and then commence again.

The plateau may be looked upon as a peculiar kind of fluctuation or deviation from the true course of learning. It is a deviation which extends over a number of trials. The most common form of deviation is that which occurs very frequently in practically all learning curves and consists in sudden up or down

deviations from the general trend of the curve. In Plate IV, Curve A, we have such downward fluctuations at the 8th, 12th, 14th, etc., trials, and an upward fluctuation at the 7th trial. But these fluctuations are much less frequent and much less prominent in Plate IV than they are in curves plotted from the data of just one individual. These fluctuations from trial to trial have already been referred to in Lesson 5, where an explanation of their cause is given.

What light do the data secured when the mirror is not used throw upon the main result of this experiment?

The data secured when the mirror is not used give us a clear idea of just how fast and accurately the subject can do the drawing without the mirror. The efficiency shown measures the strength of the old bonds formed in drawing, writing, etc., which function here. There is no reason to suppose that with sufficient practice the subject could not reach this efficiency under the new experimental condition. These data then give us some idea of the possible limit to the learning curve obtained in our twenty trials. But it is true that further practice without the mirror would lead one to draw the star in less time and more accurately. Consequently even this determination obtained without the mirror is not low enough for the final limit that might be reached by a vast amount of practice in the mirror. The final limit that an individual might reach with unlimited practice is called the *physiological limit* to the learning. It means that the physiological processes involved in the performance require a certain time and that when one reaches this limit one cannot progress further. It is extremely unlikely that the ordinary individual ever reaches his physiological limit in more than a very few simple processes which he has practiced vigorously a great many times. In most things we are very far from the limit. The world's record of 9⅗ seconds for the 100 yard dash represents the physiological limit of the best sprinter. Few, however, have ever reached their limit in this performance.

The plateau, referred to above, may be thought of, then, as a *temporary limit* in distinction to the *physiological limit* which is the final permanent limit of progress.

What applications can you make of the principles you have discovered to your own work?

One of the greatest needs today in our educational work is to

provide adequate means of registering the daily improvement of the students. If one can see himself improving he becomes very much interested and consequently does very much better work. The use of such curves as employed here enables a child not only to race against others but to race against himself. If he loafs, his curve shows it very clearly; if he works very hard, the curve registers that fact. Ordinarily only the superior children can obtain the thrill of winning in a scholastic race as school work is usually administered. But with the use of learning curves a dull child at the bottom of the class may experience the feeling of victory when he sees his curve rise. The presence or absence of a feeling of confidence in oneself may account for many of the successes or failures in life.

As an example of just how a learning curve may be used to great advantage the following case supplied by Martha Carroll is of interest.

"After a year and a half of unsuccessful attempts to stimulate anything worthy of the name of effort in an eleven year old boy pupil, I decided to make an attempt at a learning curve of some sort. The subject being music (and violin at that) it seemed almost an impossibility to figure out a method by which a record might be kept and exact progress noted. As an exact record of progress made, the curve (see Plate V) is a failure, but it accomplished its purpose of stimulating an effort.

"The lessons were 45 minute periods once a week—30 minutes being devoted (approximately) to the lesson assigned the previous week and 15 minutes to the new lesson. The record was kept during the period of assigned lesson only, any errors in the new lesson being left uncounted.

"The understanding with the pupil was, that for every correction I must make during the 30 minute period a mark would be made—these marks to be counted and stand for the grade at the end of the lesson. It was also agreed that no error noticed, and corrected by the pupil should be counted against him. The errors were to include those of position, intonation and rhythm—accuracy being the sole end in view.

"At the first lesson where the record was kept I made 40 corrections during the 30 minutes. For the first time, the child became aware of the fact that he did not 'know everything about it,' and that he was *not* 'doing it right.' He became intensely interested,

and from then on watched like a hawk every mark made against him and was very soon seeing his own mistakes and correcting them before I had a chance to do so.

"The first record was made on Feb. 22, 1916, and on May 23, 1916, the final record was made; the score having been reduced from 40 errors to 5 at the lowest record—and closing with a score

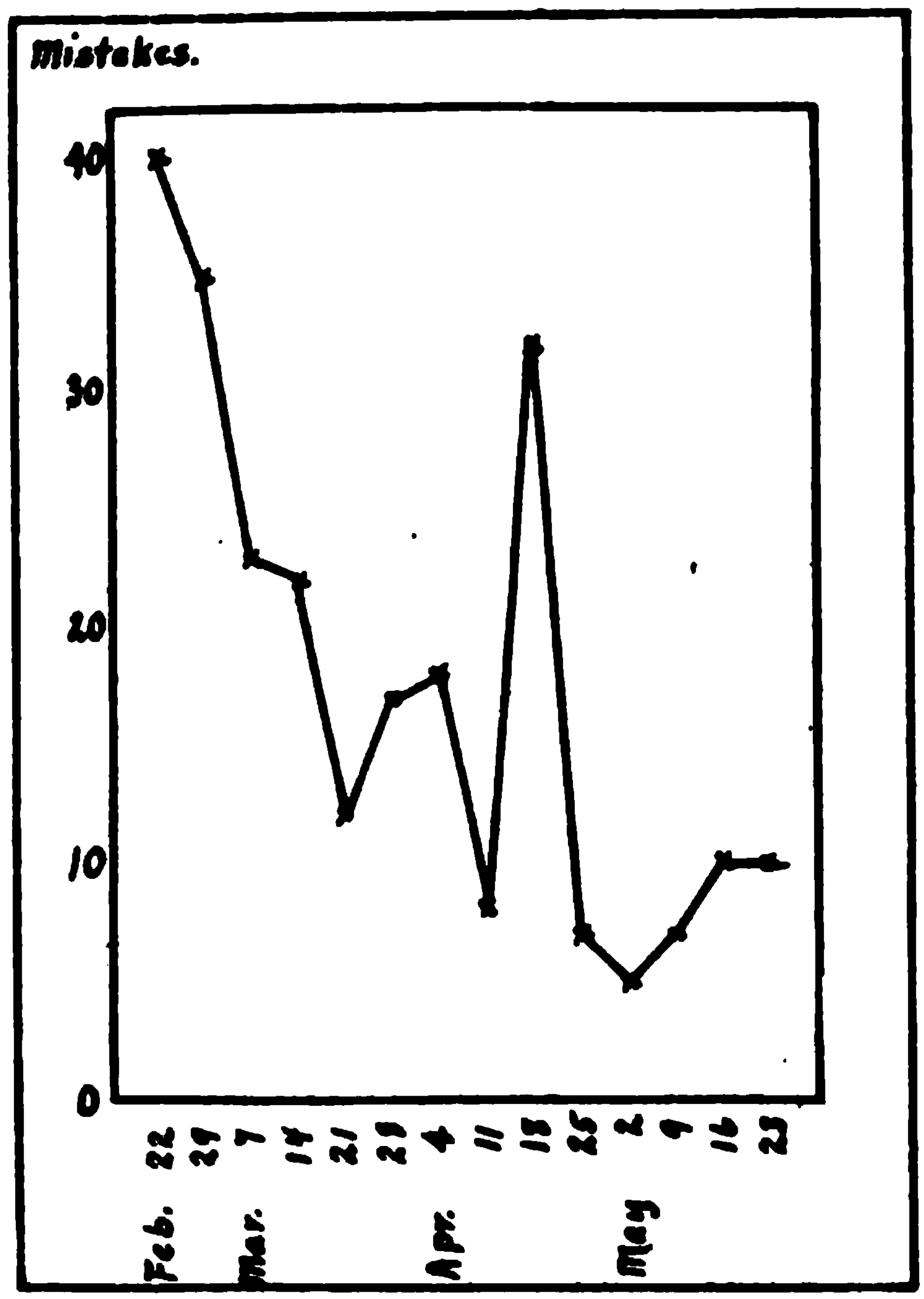


PLATE V.—Curve showing progress in eliminating errors in learning to play the violin.

of 10 errors. That the actual amount of progress made is not evident, may be seen from the fact that at the time of the last record fully 3 1-3 times as much ground was covered in the 30 minutes as at the time of the first record, thus reducing considerably the percentage of errors at the final record.

"The change was entirely one of attitude, for the amount of actual practice time spent between lessons was *not* increased.

"The sudden rise in the curve at the ninth record I attribute to a return of the original attitude of self-satisfaction."[1]

Knowledge as to how fast a child of a certain age could possibly add columns of figures (physiological limit) would be helpful in handling him, especially when his work shows that he is on a plateau. By this we do not mean that our ideal is to have a child even approximately attain his physiological limit. Far from it. But it would help keep us from fearing to overstrain the boy when what he needs is to be urged to do his best.

Kate Anthony reports a case of an exceedingly bright boy who was but 9 years old but had been advanced to the 6th Grade. He stood at the head of his class in all matters of originality, initiative, and clear thinking but near the bottom in speed of handwriting, in drawing, and manual work. She believed his inability to do these latter performances as well as the average member of the class was due to his immaturity. An 11 or 12 year old boy is physically stronger and more dexterous than a 9 year old boy, just because he is two or three years older. And this difference is great enough so that a 9 year old bright boy is seriously handicapped in competing with an average 12 year old. If Anthony's conception is correct, i. e., that her 9 year old boy was doing poor work in manual training just because he was too young, then there was no need of worry about his poor performance. He was doing as well as could be expected of a 9 year old, although it was not 6th Grade work. But if she is wrong and he did poor work because he was not interested or not gifted along these lines, then extra effort should be put forth to get him to do better. An exact knowledge of what different aged boys could do and what they naturally do in manual training would help her here in determining how to handle him.

Mary McGahey found it impossible to improve Carl's arithmetic work as to speed. He was a 6th Grade pupil and did good work but did not solve simple arithmetical problems as fast as he should. The fact that McGahey knew that his rate of work was much below what an average boy could do made her realize that Carl was on a plateau which was far from being his physio-

[1] A very good example of how such methods have been utilized in industrial work is recorded by R. B. Wolf in *The Creative Workman,* published by the Technical Association of the Pulp and Paper Industry. See also, J. Q. O'Brien, *Silent Reading,* 1921, for extensive use of this device in teaching.

logical limit. This made her realize that something was wrong and that it "was up to her" to find it. Finally she noticed that he tapped twice before commencing to solve the simple combinations as $\begin{array}{r}4\\2\\\hline\end{array}$, $\begin{array}{r}8\\3\\\hline\end{array}$, $\begin{array}{r}7\\1\\\hline\end{array}$, $\begin{array}{r}4\\0\\\hline\end{array}$, etc. On calling his attention to the matter and then reproving him every time he did tap, she quickly broke him of the habit. As a result he increased his rate of work 50% in a few hours' time. If McGahey had not known (1) what a child of Carl's age ought to do and (2) that he was making no progress, she would probably have never discovered the tapping and so never have trained him to do arithmetic problems at an efficient rate. (The tapping is undoubtedly a survival of an earlier habit of counting by making dashes on paper, instead of with one's fingers. Apparently Carl on finishing writing 6 as the answer of $\begin{array}{r}4\\2\\\hline\end{array}$ had to tap twice before commencing to think what $\begin{array}{r}8\\3\\\hline\end{array}$ meant. Under such a method he had pretty nearly reached his physiological limit. When the tapping was eliminated he was able to think the answer 11 to $\begin{array}{r}8\\3\\\hline\end{array}$ while writing the 6 and so could write continuously the answers to these problems, working out the answers ahead of where he was writing.)[1]

In Plates VI and VII are given the learning curves of four children (C, D, G, and H) when tested with simple addition and multiplication combinations. (The test blanks are shown on pages 152 and 153.) The records show how many combinations were performed correctly in one minute on fifteen different days. C gained twelve problems in addition in eight days and D the same number in five days, both completing the blank of eighty combinations in two minutes. G, on the other hand,

[1] Kate Anthony, Mary L. McGahey, Edward K. Strong, Jr. The Development of Proper Attitudes Toward School Work. *School and Society*, Dec. 25, 1915, p. 926ff.

gained but two problems in fifteen days and H none in the same time. In multiplication C gained twenty-four problems; D, twenty-four problems (in fourteen days), G, nine problems, and H, sixteen problems.

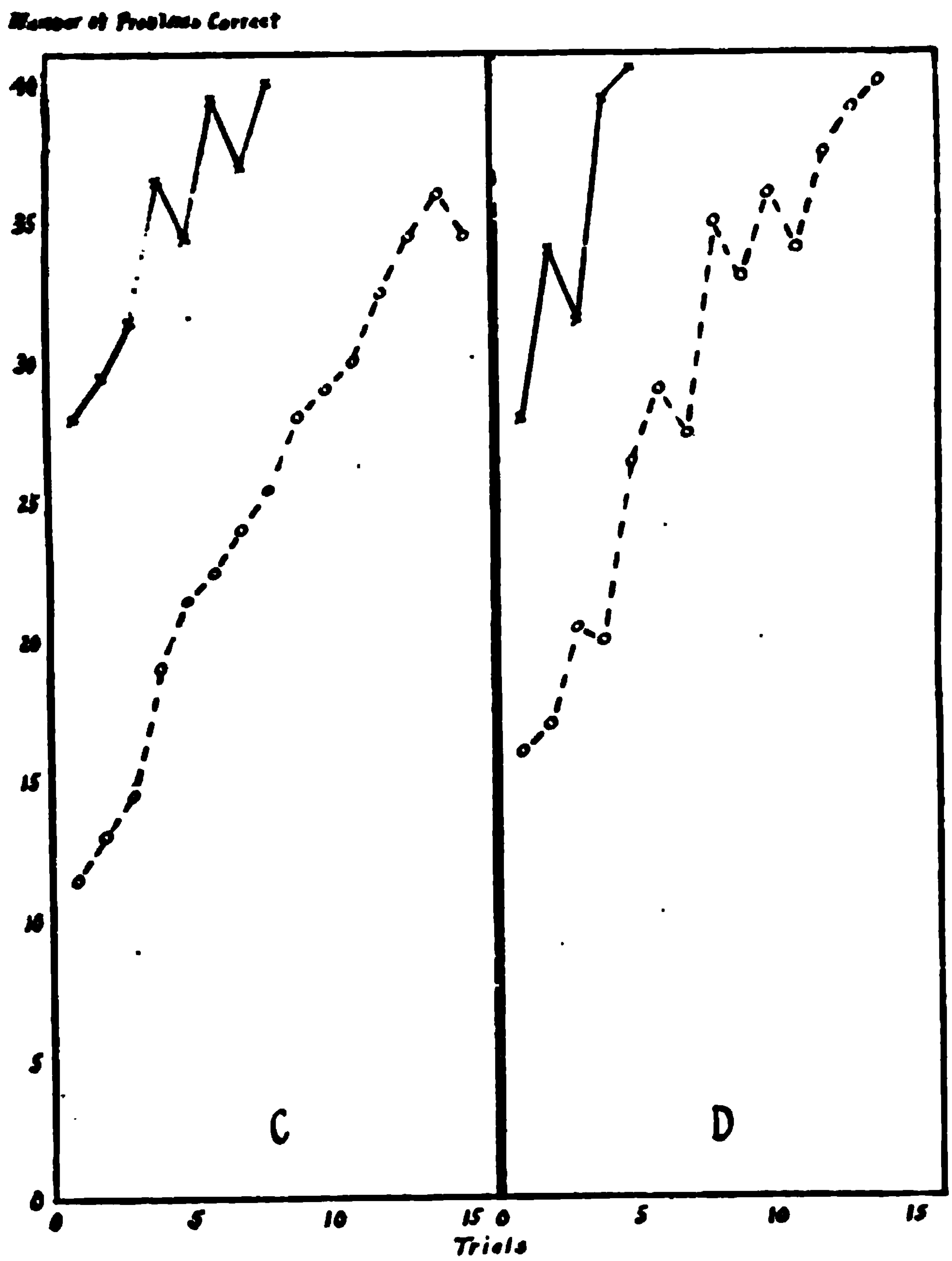


PLATE VI.—Learning curves of C and D in simple addition (shown by the solid line) and multiplication (shown by the broken line).

Learning curves such as produced by C and D are typical of bright capable children while those curves produced by G and H are typical of children who stand near the bottom of their class. The curves of G are the poorest from the point of initial score or slope. This child never belonged in the 4th Grade and so dropped out of the school as there was no room for him in the

3rd Grade. His curves show markedly inferior knowledge of addition and multiplication and that he cannot learn rapidly. In fact he learns more slowly than other children in the same grade. There is then no chance of his catching up with his class. Instead he is going to be left farther and farther behind.

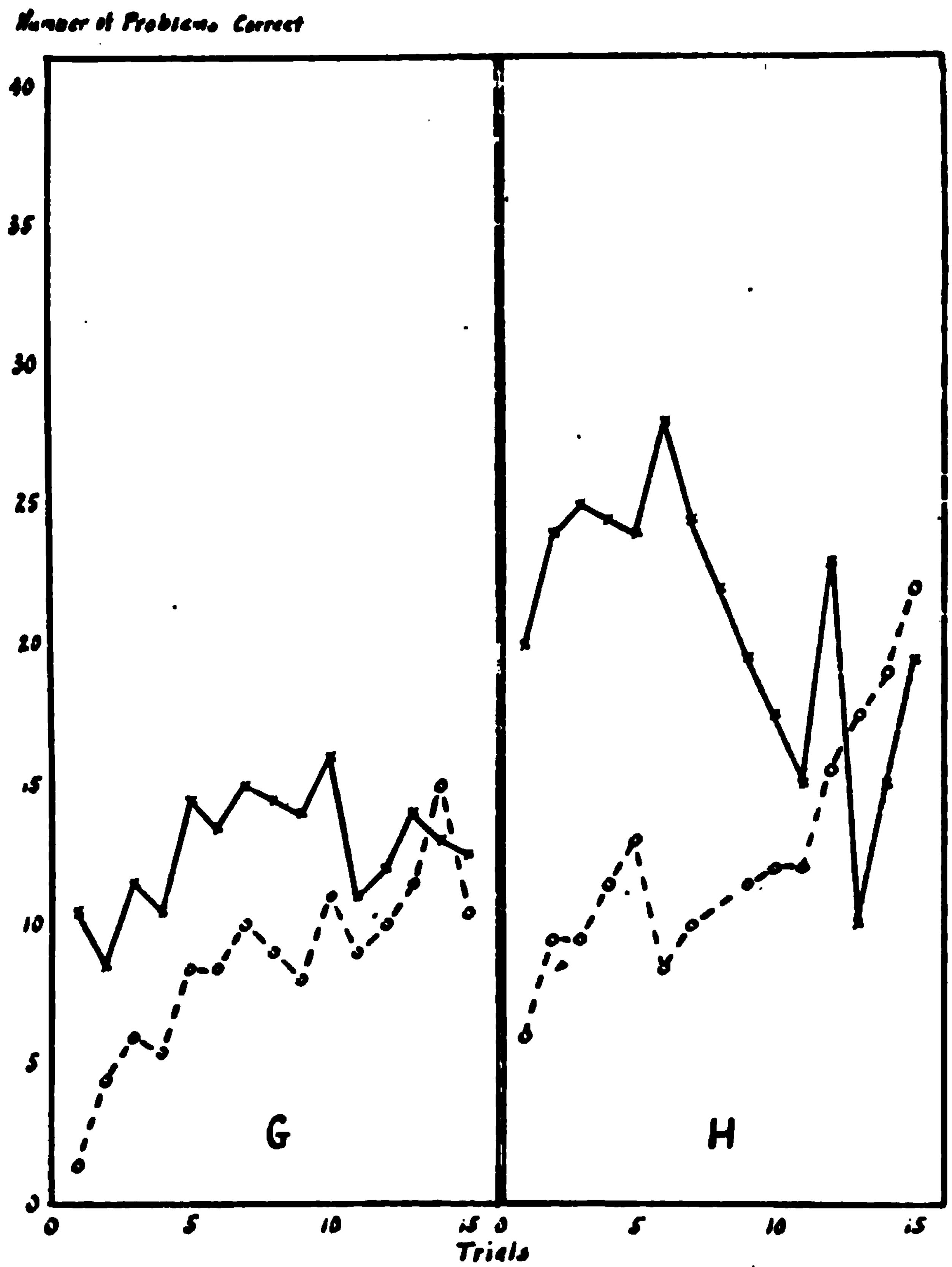


Plate VII.—Learning curves of G and H in simple addition (shown by the solid line) and multiplication (shown by the broken line).

H's addition curve is very striking and unusual. As she improved in multiplication she lost in addition. In this instance there was a clear case of *interference*, i. e., the habit of "seeing 4 × 3 and thinking 12" was interfering with the habit of "seeing 4 + 3 and thinking 7." She continued in this condition for some time afterwards. Later in the year she was put through

another practice series. The addition again showed an interference effect from the multiplication. In time she overcame this interference and eventually after three months of individual drill reached a speed of 40 problems in one minute in both addition and multiplication and a good speed in subtraction and column addition. But she has shown no ability to solve ordinary problems in arithmetic. A year later she was given these tests again. Her records were excellent, showing she had retained most of what she had learned. But her performance in more complicated arithmetic work was extremely poor. She never succeeded in solving problems requiring any original thinking.

LESSON 8

RELATIONSHIP OF METHOD, ATTITUDE AND FEELING TO LEARNING

Some of the more obvious laws of learning have been presented. We are now ready to attempt a more careful study of less apparent factors.

What happens when we change our method of doing a certain task—say of playing golf, of going from the sight to touch method in typewriting, or discovering a new way to solve originals in geometry? Do our feelings affect our work? We think they do: but do they really do so? Does the man that is confident do better than the man that is fearful? If so, why?

MIRROR-DRAWING EXPERIMENT (repeated)

Problem.—What factors are involved in learning Mirror-Drawing?

Apparatus.—Mirror-Drawing Outfit; 10 six-pointed star blanks; watch.

Procedure.—E should here be the S of the 6th class-hour and S the E of that exercise. Follow the general procedure of the 6th class-hour, but here S should only draw with the right hand in the mirror.

The emphasis is *not upon completing* 10 drawings *but upon obtaining as detailed an idea* of how one learns as is possible. Consequently after each drawing, S should note down every fact that occurs to him regarding his method of doing the work, the ideas that came to him while doing the drawing, his attitude toward the work, his feelings, etc. E should also record changes in *method* which he notes in S, changes in *feeling* or *attitude* toward the work, etc. Note down, for example, every sigh or exclamation of impatience, and ascertain if there is any relation between its occurrence and success or failure.

Results.—E should have recorded, (1) the time of each performance, (2) the number of errors in each drawing, and (3) the observations of both S and E accompanying each performance.

Draw three curves as in the 6th class-hour experiment.

Questions.—(1) What changes take place when the same performance is repeated a number of times? Consider (*a*) differences in method or "mode of attack," (*b*) differences in attitude toward the work, (*c*) differences in feeling and emotion.

2. How do such changes affect the changes in speed and accuracy?

3. How are improvements hit upon? Were they (*a*) accidental, (*b*) partly understood, or (*c*) thoroughly understood beforehand?

Applications.—What applications can you make of the laws you have discovered here to your work?

Write up this experiment and hand it in at the next class-hour.

LESSON 9

RELATIONSHIP OF METHOD, ATTITUDE AND FEELING TO LEARNING (continued)

What Changes Take Place When the Same Performance is Repeated a Number of Times

Method or "Mode of Attack."—There are a number of different methods of doing the mirror-drawing. Most individuals learn through trying this thing and then that. Here and there is an individual who utilizes his knowledge of physics and figures out how his movements should be made. But in even these cases there is considerable of the "try this, try that" performance. Then again, most individuals direct the movement very largely by the eye. But occasionally an individual initiates each new movement in terms of the relationship of his pencil to his little finger. If he desires to move toward his little finger (determined through vision) he then moves his forefinger and thumb toward his little finger—the guidance being in terms of finger-movements, not in terms of vision. The eye is used in this case simply to record the general direction desired and to guide the pencil between the two red lines.

As practice continues the individual may steadily improve on the details of his procedure or he may from time to time try other methods. In the latter case he may return to his first method or he may abandon it entirely. There is no general rule to be laid down as to the course of these changes. Each individual should, however, endeavor to ascertain as accurately as he may just what changes did take place in his own case.

Attitude toward the Work.—Ruger[1] calls attention to three different general attitudes toward one's work. He calls them (1) the self-attentive attitude, (2) the suggestible attitude, and (3) the problem attitude.

The *self-attentive attitude* is illustrated by him by this extract

[1] H. A. Ruger, *The Psychology of Efficiency*, 1910, p. 36ff.

from a man's account of how he solved a puzzle. "It seemed to me that if anybody had given it to me without saying that it was a puzzle (a bona fide one) I would have said it was impossible up to the last minute. I have a feeling now of loss of esteem. I had this all along because I couldn't do something which was made for people with ordinary brains to do. One conclusion that kept running through my mind all the time was that I had a subordinate mind. I couldn't help having a gleeful, self-satisfied feeling when it actually seemed to be coming off, although it was a surprise."

Individuals possessed with this self-attentive attitude expressed themselves as being afraid that the experimenter was getting bored because they were slow, or that he would think them extremely stupid, etc. The principal thing, then, that occupied the minds of people with this attitude was the concern as to their general fitness and as to what others would think of them.

The Suggestible Attitude.—Ruger says, "In two of the men there seemed to be a special sensitiveness toward any movements of the operator which might give an indication as to the course to be pursued. In such cases as this there is a lack of confidence in the self but the attention is directed not to the self but to some other person. The center of gravity, if one may so describe it, of the responsibility is located elsewhere and the suggestions, intentional or unintentional, of the other person or persons concerned are accepted uncritically. This tendency was noted by the writer in his own case in novel situations of a more distinctly social type, such as business transactions of an unaccustomed sort, or other similar cases where persons instead of things were to be dealt with and where the other person was felt to have superior information as to the matter in hand and the self to be deficient."

Probably all have experienced this attitude when attempting to do something new while in the presence of others. This is particularly true when those present are known to know more about the task than oneself. Their presence bothers us; very often we make mistakes that we know we would not make if we had been alone. Here our attention is directed even more toward those who are present than to the work before us. And at such times we are especially susceptible to any indications from these persons as to whether we are doing well or poorly.

The Problem Attitude.—"In contradistinction to these two attitudes, which are certainly not favorable to efficiency," this third attitude is essentially an attitude of self-confidence. "The self-confidence is not one of sluggish complacency, however, but is expressed in a high level of intellectual activity, of attention. Attention would be directed to the thing to be done rather than to appraisal of the self."

In this particular experiment undoubtedly most subjects had somewhat of the self-attentive attitude, or the suggestible attitude, or both to start with. And as practice continued the earlier attitude faded out more and more and the problem attitude took its place. Occasionally a subject displays only the problem attitude throughout the practice period. And occasionally also a subject continues to show the self-attentive attitude throughout, but this is rather rare. Usually there is a noticeable change toward the adoption of the problem attitude.

Some of the factors that bring about this change in attitude are the realization that one is improving, that one can do the task, that another is doing it successfully, etc. But sometimes the latter factor reacts in just the opposite way. Later on in this course, we shall return to this subject of attitude towards one's work, and endeavor to discover the causes of these attitudes and the ways in which the third attitude may be substituted for the first two. In the meantime accumulate what information you can on the subject, as it is undoubtedly one of the biggest problems a real teacher has to face—the problem of making boys and girls and men and women really self-confident about their work.

Feeling.—*Feeling* is technically either *pleasant or unpleasant.* Besides these two aspects of feeling there are the *emotions* of fear, hate, love, anger, etc. It is not likely that a real emotion is aroused in this experiment, except that of anger, and only then in the case of a few individuals.

During the first few trials the work did not go smoothly. One realized that he took altogether too much time in doing the drawing and that there were too many mistakes. Continued failure to accomplish what is desired always is accompanied by an unpleasant feeling. If this is continued too long anger will arise. But as the practice progressed, the work became easier, fewer mistakes were made, and the whole drawing took less time. With each improvement there came less and less of

unpleasantness and more and more of pleasantness. So after a time the original feeling of unpleasantness changed over to pleasantness. Then one was really interested in the task.

As practice is continued, however, the improvement becomes less and less (refer again to Plates I and IV). The novelty of the task disappears, and thoughts come to mind of more interesting or of more valuable performances that one might be doing if it weren't for this required task. The inability to carry out these performances because of the mirror-drawing may then bring again into consciousness unpleasant feelings. Whether one does then change from a pleasant to an unpleasant feeling-attitude toward the task at the close of the experiment will depend on the interplay of the pleasantness associated with the continued improvement versus the unpleasantness due to physical fatigue, inability to do other things, etc.

Even if one does thus swing from unpleasantness to pleasantness, and then back to unpleasantness again, one is very apt to discover that the last two or three trials bring pleasantness again to mind. Especially is this true of the last trial.

(Are these changes in feeling typical of all learning? If so, to what extent should a teacher pay attention to them as shown in his students? How might the second change from pleasantness to unpleasantness be avoided? If these changes are not typical of all learning, how do they differ here from other examples of learning?)

How Do Changes in Method, Attitude or Feeling Affect the Changes in Speed and Accuracy?

It is pretty clear that the changes in speed and accuracy produce very profound changes in method, attitude, and feeling. It is a fair question to ask, on the other hand, if the latter changes affect speed and accuracy. If they do not, it is immaterial whether the learner has a self-attentive attitude or a problem attitude, whether he is in a pleasant or unpleasant mood.

Changes in method profoundly affect speed and accuracy. Even such slight changes as from clutching the pencil as if life depended on it to holding it naturally result in less fatigue and consequently in smoother lines and less unpleasantness. When

careful notes are kept it is often very easy to see that with a change in method there has come decided changes in speed or accuracy. In fact from a study of the time-curve and the accuracy-curve one may often be able to check up the introspections (an introspection is technically an observation of one's own mental processes) of the subject as to just when he commenced to emphasize one of these elements more and the other less.

From our analysis of the three attitudes one may have toward his work, it is clear that one is reacting in the first two cases not only to the details of the mirror-drawing itself but to other details which have nothing to do with the task in hand—details such as one's feelings, one's estimate of himself, the movements of the experimenter, etc. As one can only be affected by a certain number of details, the elimination of these useless details may make it possible for another detail in the mirror-drawing task to affect one. If this new detail is the one that must be reacted to before further progress may be made, then the change in attitude may bring about an improvement not otherwise possible. This is just what we all have noticed many times. Worry, excitement, thoughts of ourselves and others prevent the really important details for the solution of our work from coming into play. The problem attitude represents then that attitude under which we are less affected by unimportant details. The other two attitudes represent conditions of work when certain unimportant details are being reacted to and necessarily other important attitudes are not being reacted to.

How are Improvements Hit upon? Are They (A) Accidental, (B) Partly Understood, or (C) Thoroughly Understood?

Observations from different individuals vary greatly upon this subject. One individual may proceed very slowly and observe very carefully what is to be done and just what he is doing and slowly develop the proper method for doing the experiment. In his case there will be a noticeable number of "planned out" movements. Another individual may make no "planned" movements at all, at least as far as he is able to report the matter. All that such an individual is aware of is that he kept trying first one way, then another, in apparently a very aimless sort of way

and that as time went on he came to realize that he was doing better and better. Moreover, from time to time he also came to realize that he was doing this particular part of the work in this particular sort of a way. For example, that when from the mirror it seemed as though he should move his hand away from his body he then moved his hand toward his body. But the significant part of this discovery lies in the fact that he was already more or less successfully making this movement toward his body when it looked as though he should move the hand away from him before he was conscious of the matter. That is, the improvement was hit upon apparently accidentally and later it became understood. (A few paragraphs below we shall come to see that the improvement was not hit upon accidentally, but was the true resultant of what had gone before, but for the present we may think of it as accidental.)

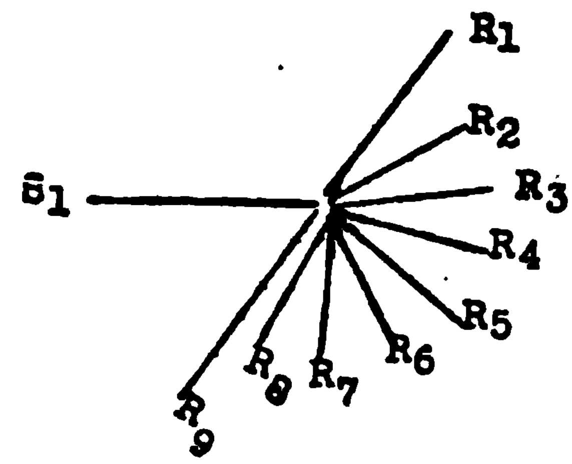
The types of learning illustrated by these two individuals appear at first hand to be very different. The first individual plans out his work, the second hits upon it "accidentally." In one sense they are very different. The former represents the highest type of human learning, whereas the latter represents the lowest type—a type common to both human beings and to animals. But when these two are carefully studied we discover that they only differ in degree, not in kind. Although it is true that the first individual "planned" out some of his methods and movements, yet he did not plan out all of them. Many of them, usually the great majority of them, he first unconsciously learned how to do and then later discovered that he was doing them. We shall want to characterize the learning of these two typical individuals by saying that the second unconsciously learned nearly or entirely all that he did and later became aware of part of what he was doing, whereas the first consciously planned out a few of his movements before starting to do them while learning the rest in the same way that the second individual acquired his.

Learning to do a task similar to mirror-drawing is largely characterized by the unconscious development of movements which, after they have become fairly well established, are likely to become consciously noticed. Such learning has been called *trial and error* learning. The expression is not a good one, but it has been widely used by writers on this subject. The essential

characteristic of this sort of learning is that we do not have at hand a suitable movement (response) to the situation. In terms of situation, bond and response, there is no bond existing between the situation confronting the learner and the correct response. For example, at point 3 on the star-blank one must proceed towards 4 (situation). To do so one must make certain movements (response.) In order to do so the situation and the response must be connected by a bond. Such bonds cannot be formed voluntarily. The only way open is to try one movement after another until the right movement is hit upon. Every time an improper movement is tried it is checked immediately since it leads the pencil in a wrong direction. On the other hand, every time the correct movement is tried it is not checked but allowed to continue. In this way eventually the situation is tied up with the correct response, inasmuch as the bond connecting the two has been used more than any other. The selection of this correct movement is not consciously done. It becomes consciously known only after it is fairly well developed.

This type of learning might be illustrated roughly in this way. Suppose P and Q, who is blindfolded, are standing in the middle of a recently harrowed field, or one covered with snow. P determines just to which part of the field he wants Q to go but he doesn't tell him. Q is to discover this point by keeping walking, agreeing to change his direction whenever P calls out "change" and to keep going when P says nothing. Now when Q starts he is as likely to go one way as another. The consequence is that he will start a number of times and because they are wrong P will so signal and Q will stop and start again. The snow about the starting point will become all trampled because of these starts and stops. But presently Q will hit upon the correct direction, P will no longer signal to stop and Q will continue in the desired direction. If he walks in a straight line he will presently reach the desired point. If he doesn't P will signal to change and Q will then make a few stops and starts, finally hitting on the correct direction again. In this way Q will finally reach the desired point. He has reached it through starting many incorrect movements which were immediately checked and then continuing the correct movement whenever hit upon. Now suppose P and Q start over again. The process will be largely the same as before. But as it will be easier walking

wherever Q has traveled before, Q will be much more likely to continue in old paths than to make new ones. And as the correct direction is the only one that continues for any distance Q will be aided by it much more than by the little short paths that lead in the wrong direction. Still on the second trial Q's guidance will come essentially from P's signals. As P and Q keep up this stunt, the correct path will become better and better formed and Q will gradually come to rely on it more and more and to need



P's signals less and less. After a certain number of trials it is likely that Q could traverse the distance with no mistakes, utilizing the well-worn pathway as a guide instead of the signals of P.

All learning consists in forming a new situation-bond-response combination. In forming such a new combination we must start with some already formed combinations as a starting point. In the case of drawing line 1–2 in the mirror we start with the combination of situation (direction toward one) and response (movement of hand toward body), indicated in the diagram by S1 and R1. But the response R1 is incorrect. Many other movements (R2–R8) are attempted. Each is checked immediately. Finally movement R9 (which is to move hand away from body) is commenced; it is not checked, and so is continued until 2 is reached. The old customary habit, situation (direction toward one) response (movement of hand toward body) has thus been modified so that we now have a new habit, i. e., situation (direction toward one) response (movement of hand away from body). R9 has been substituted for R1 as the response to S1. After a number of stars have been drawn this new habit will then commence to function efficiently. It will do so because the bond connecting S1 and R9 has reached a certain degree of strength.

Why should the nervous current discharge over the pathway to R_1, then to R_2, etc., instead of continuing to discharge over R_1? There are two explanations. First, it seems that after the discharge of current over a pathway there is required a very short interval of time before the nerve cells are in condition to discharge energy again. This factor accordingly tends to divert the current to some other pathway than the one just active. And second, when the discharge does not produce the desired response, when there is a blocking of a discharge in any way, an increased amount of current is released. This phenomenon is called *overflow of energy*. This is easily demonstrated when one tries to solve a puzzle—one becomes more and more excited and exasperated as repeated attempts fail. One sees the same thing illustrated in mowing the lawn. When the lawn mower is jammed, one pushes and pushes, rather than stops and cleans out the stick or clump of grass from between the knife-edges. Only when the pushing fails does one resort to the rationally more sensible procedure. It is very likely that this is largely responsible for the formation of the new bond, for the excess energy discharges over all manner of pathways, including those of very high resistance, and so operates to make them more easily used next time.

The reason we "hit upon" the proper movements "accidentally" and later become conscious of them is apparently that until a bond has reached a certain degree of strength we are not capable of being aware of it. When it finally has reached this degree of strength through use, we then suddenly realize just what we are doing. In terms of the snow field scene Q will not at first notice that he follows his former footsteps in preference to walking through unbroken snow. After a time, however, the difference in ease of walking along a path as compared with walking through the snow is forced upon him. After that he is as much influenced by this detail of the situation as by P's signals. And in the mirror-drawing experiment the subject at first doesn't know how he gets from point 1 to 2. After a time, however, he realizes that to go to 2 from 1 you move in the opposite direction from what you want to, or he may not reach such a generalization but tell you that he disregards what he sees and allows his fingers to guide the movement. In the first case he has clearly in mind what he is doing. In the latter he is more in the stage of Q when he has just commenced to pay attention to the feeling of

path versus no path without thinking particularly about the meaning of this difference.

Let us return now to the original question:—"How are improvements hit upon? Were they (a) accidental, (b) partly understood, or (c) thoroughly understood?" Fundamentally we have in such a type of problem as this mirror-drawing experiment a case where an old situation-bond-response combination is modified so as to give us a new response to the same situation. Whenever the response is changed there results movements more or less of the "trial and error" type, i. e., the starting of many incorrect movements which are immediately checked and the final development of the correct movement through its being allowed to continue. In all such cases the correct movement will be "hit upon" just as "accidentally" as are any of the incorrect movements. Its first use is "accidental." Its second, third, fourth, etc., uses are also accidental. But eventually the bond connecting the situation and the new response reaches a certain degree of strength and the process becomes a conscious one. The normal thing is for improvements to be hit upon first and later to become consciously known.

But there are cases where we do consciously plan out the movement before we commence making any movements at all. These are cases which we shall study more intensively later under the headings of *reasoning* and *transfer of training*. It is sufficient now to say that in these cases the subject has experienced somewhere else in life some situation similar to the one now confronting him and that he now makes use of some of that experience in this case. For example, a subject who has previously studied physics may have learned the principle that vertical lines are inverted as they appear in a mirror but not horizontal lines. This principle may have been connected up as a response to the situation "mirror." Now when confronted with the mirror in this experiment, the mirror detail of the whole situation in the experiment calls to mind the physical law. The law then becomes an added detail to this subject's entire situation. He acts in terms not only of the situation as other subjects perceive it but also in terms of this detail—the physical law. And acting in terms of the law he has little or no trouble with the vertical and horizontal lines in the experiment. This statement must be modified somewhat, however. It is true he will have less trouble

than the average individual if he has in mind the physical law. But he will have still considerable trouble, unless in his physics course or somewhere else he has *actually* drawn objects as seen in a mirror. When one must make a new movement in response to a situation one can only learn to make it by doing it and this doing involves "trial and error." If he has not had this experience, he will profit by knowing the law because he will much more quickly check the wrong movements since he will have a guide in not only what is *seen* but also in what is *felt* in the hands. Knowing that he must move his hands away from him in going from 1 to 2, he will feel in his hands that he is going wrong as soon as he moves in any other way.

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LESSON 10

HOW DOES ONE LEARN A VOCABULARY?

Is the learning of a vocabulary an entirely different performance from the learning of handwriting? Or are there certain parts of each that are more or less similar? What are the processes involved in memorizing a vocabulary? Is there a one "best" method for all individuals or are there different methods which are best adapted to different individuals?

In this experiment E will pronounce a Spanish word and S will be expected to give the English equivalent. If he can't E will prompt him and a little later try him again. As the promptings continue S will gradually learn the vocabulary. Devote your time and ingenuity in this experiment to discovering how S learns the pairs of words. In some cases S will frankly not know, in other cases he will say the sound suggested the English word, in other cases he will have other answers. Endeavor to discover as accurately as possible just how S learned each pair.

A few students, particularly men, take an inordinate amount of time to learn their vocabulary. Yet if there were a thousand dollars at stake they could do the task in a few minutes. Do not allow a wrong attitude to interfere with your work. Get it done quickly.

The Experiment

Problem.—How does one learn a Spanish-English vocabulary?

Apparatus.—E receives from the instructor a list of 25 Spanish-English words, which S is to commit to memory. (If S knows Spanish E should report this fact to the instructor and secure a vocabulary in some other language.)

Procedure.—(1) E prepares a tally sheet similar to the model (Plate VIII) and fills in the list of Spanish and English words to be learned.

2. E supplies S with a list of the Spanish words (but not the English words) which S will keep before him as his prompting list.

3. Trial 1. E will read aloud to S the Spanish words and their English equivalents at the approximate rate of one pair every three seconds. S will follow with his eyes the Spanish words on his list during the reading and will endeavor to memorize the pairs as they are read. He will not write down the English words.

This first trial has, of course, 25 promptings since E read to S each Spanish word and its English equivalent. Accordingly record an "x" in column 1 of the tally sheet opposite each of the 25 pairs of words.

4. Trial 2. S pronounces the first Spanish word on his list and attempts to give its English equivalent. (*a*) If he succeeds, then stop until you have written down S's explanation of how he came to connect the Spanish and English words together. Record these observations in detail because they are the results you are especially interested in obtaining in this experiment. When this is done S pronounces the second Spanish word and attempts to give its English equivalent, etc.

(*b*) If S gives an incorrect English word, write that word in column 2 opposite the appropriate Spanish word. Prompt S as to what the correct English word is. Then have S pronounce the next Spanish word and attempt to give its English equivalent, etc.

List the Spanish words in this column	List the English equivalents in this column	Tally below in the appropriate columns the promptings needed and errors made by S in learning the vocabulary										
		1	2	3	4	5	6	7	8	9	10	11
1.		x										
2.		x										
3.		x										
4.		x										
etc.												
24.		x										
25.		x										
Total number of promptings		25										

PLATE VIII.—Showing blank to be used by E for recording promptings and mistakes.

(*c*) If S makes no reply within 5 seconds after pronouncing the Spanish word, mark an "x" in column 2 opposite the appropriate Spanish word and then prompt S as to the correct English word. S pronounces the next Spanish word and so continues.

Repeat the above procedure with each Spanish word in the list. In this way you ascertain whether S has learned the English equivalent for any of the Spanish words after one prompting (your first reading), and if so, how he learned it. And furthermore, you have a record of (*a*) how many English equivalents were given correctly; (*b*) how many were given incorrectly; (*c*) in how many cases no reply was made.

5. Trial 3. Repeat the above procedure for trial 3. Continue with trial after trial until S can give correctly the English equivalent to each of the 25 Spanish words without error and without waiting more than 5 seconds in any case.

6. If you still have time try this additional experiment. After S has recited the Spanish-English pairs correctly, have him start at the bottom of the list and call out the English equivalents as before, reading up the list, instead of down. Continue until S can recite the list correctly. What additional light does this experiment throw on the whole problem of learning a vocabulary?

Results.—(1) Count up the number of promptings (the number of "x's" plus the number of English words which were incorrectly given in each column) and record the totals at the bottom of each column. Plot a prompting-curve.

2. Record all the facts you have marshalled as to how one earns a vocabulary.

Interpretation.—Answer the following questions and give any other conclusions of interest here.

1. How does the learning curve based on promptings compare with the learning curves obtained in learning the alphabet and mirror-drawing?

2. In what different ways did S learn the Spanish-English pairs of words? What seem to be the general laws underlying such learning? Are these laws similar to or different from those related to learning mirror-drawing?

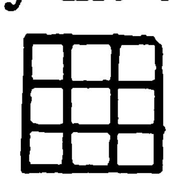
Application.—How might these methods be cultivated? Where else could the same methods be utilized?

Hand in your write-up of this experiment at the next class-hour.

LESSON 11

THE LEARNING PROCESS INVOLVED IN COMMITTING TO MEMORY A VOCABULARY

A foreign word may become associated with an English word in two different ways. It may be learned *through simple repetition*, or it may be learned *through the intermediation of one or more steps*. Take the case of the German word "hund" and its English equivalent "dog." Some individuals will come to know that "hund" means "dog" by simple repetition of the two words together. Other individuals, when confronted with "hund," will think "hound" and then "dog." When the intermediate step is employed the combination "hund-dog" may be learned with one repetition and may then function satisfactorily throughout life. When the purely repetitive method is employed the combination may only be learned after a number of repetitions and even then may not function a few days later.

Consider a second illustration. The Chinese symbol # stands for "a well of water." If one were engaged in committing a Chinese-English vocabulary, particularly at the commencement of the course in Chinese, it is most likely that the combination would be learned according to the first method indicated above—through sheer repetition of the two together. However, if one was instructed by his teacher, that the symbol # was derived originally from  and that the four outside lines had been gradually dropped, and also that the original symbol stood pictorially for a small cluster of houses □□□ about a common well, then it is quite likely □ o □ that one would need but this simple instruction (this □□□ one repetition) in order to retain for life the combination "#—well."*

* The above explanation of the symbol is not technically correct but it is the conception that Annie E. Bradshaw used in learning the symbol. The correct explanation is recorded here as given by C. W. Luh. It is of interest in this connection, as it shows how through associations a term obtains new

Learning through Sheer Repetition—Stimulus Substitution

Consider the fundamental process involved in learning "hund-dog" through sheer repetition or *rote memory.* We start with the abilities:—

1. To pronounce "hund" when we see the printed word "hund,"

2. To pronounce "dog" when we see the printed word "dog,"

3. To call to mind a considerable number of words after seeing the word "dog," such as, "Toby," "animal," four-legs," "white," "black," "yellow," "cur," etc. All of these latter combinations have been developed through experience and go to make up as a complex whole our complex thought "dog." It is quite likely when we see the word "dog" and say "dog," that there is a more or less simultaneous commencement of the processes to say many or all of the others also.

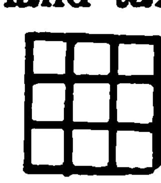
Such abilities do not impress us as adults. But if we stop to think a moment we realize that small children can not do these seemingly simple things; hence, we must have learned them at some time.

It may be that we have never pronounced "hund" after seeing the word. But we are able to do so because of the existence of still simpler abilities which we possess, namely:—

---

meanings. This word, "well," is derived from an ancient hieroglyph. The square in the middle represents the mouth of the square rail of the well. Around it are walls slanting towards the ground. The resemblance is more remarkable when we write the word in an older style, like 井

The "well system." During the Dynasty of West Chau (1122–769 B. C.) the land tax was paid in community labor. Each square (about ⅛ sq. mi.) was divided into nine allotments, like



The middle square was public land, the products of which supported the central government. Eight families were assigned to the farmsteads around it, and they worked on it as they did their own farms. The arrangement of the farms, with their fences and pathways looks just like the word (井). So we have come to call it the "well system." "For a time, it was a very effective method, and the management of these farms became a byword for order and cleanliness. So the word became an adjective. In rhetoric we double it (井 井) and this means 'very orderly.' "

1. To pronounce "h" when we see the letter "h,"
2. To pronounce "und" when we see the letters "und,"
3. To connect up the two sounds into one word, i. e., "hund."

The more we fall back upon these simpler abilities when attempting to pronounce "hund" the first time the more slowly and with the more hesitancy will we pronounce the word, coupled with an increase in speed and confidence with successive trials. That this point may be better appreciated, watch yourself master the pronunciation of the following words: "handwörterbuch," equilibrating," "concaturating."

Having disposed of the problem of pronouncing "hund" when we see the printed word "hund," let us restate what we have to start with in the form of a diagram.

Situation		Response
(1) seeing "hund"	——→	pronouncing "hund"
(2) seeing "dog"	——→	pronouncing "dog"
(3) seeing "dog"	——→	thinking "Toby"
(4) seeing "dog"	——→	thinking "animal"
	etc.	

The problem is to connect the situation (seeing word "hund") with the existing responses to "seeing dog," i. e., to connect with the first situation in the above table the responses to the second, third, fourth, etc., situations. In terms of a diagram the problem is to develop the dotted line below:—

Situation	Response	Secondary Rseponse
seeing "hund" ——→	pronouncing "hund"	
seeing "dog" ——→	pronouncing "dog"	→thinking "Toby"
		→thinking "animal"
		→thinking "cur"
		etc.

It is apparent from our experience in the experiment of Lesson 10 that a new connection or bond, such as indicated by the dotted line above, can be developed by mere repetition. Expressed in a more general way we have:—

Situation 1	——→	Response 1
Situation 2	——→	Response 2

with the generalization that *repetition of S1—R1 and S2—R2*

results in the formation of a new bond S1—R2. (Theoretically, two new bonds tend to be formed, i. e., *S1—R2* and *S2—R1*. Practically, one only is formed. Which one of the two is formed depends upon the relative satisfaction to the learner from the two different responses.)

One of the classical experiments illustrating this law was performed by the Russian psychologist, Pawlow. He rigged up an apparatus on a dog to measure the flow of saliva. Then he showed the dog a bone and at the same time gave him an electrical shock. In diagrammatic form:—

1. Electrical shock ⟶ 1. Skin withdrawn from contact.
2. Presence of bone ⟶ 2. Increased flow of saliva.

After a number of such repetitions, the bone was no longer shown and it was found that the saliva flowed in response to the electrical shock just as it had originally done in response to seeing the bone. The experiment thus demonstrated the development of the new bond.[1]

Situation 1, electrical shock·········→ Response 2, saliva flows.

In this case R2 (flow of saliva) is more satisfying than R1 (withdrawal of skin from contact) and so the connecting S1—R2 was formed.

Now in order to be sure that the reader understands not only the nature of stimulus substitution but also that that is the principle of learning underlying what is popularly meant by rote memory, let us analyze another case. Suppose one wants to memorize "13^2 = 169." We have:—

Situation		Response
seeing "13^2"	————	saying "thirteen squared"
seeing "169"	————	saying "one hundred sixty-nine"

The two original bonds were developed in connection with learning to read and to solve arithmetical problems. Through repetition the new bond (13^2—169) is formed. The process is stimulus substitution or rote memory.

[1] The term "conditioned reflex" is used in this connection by some writers to cover those cases included here under "stimulus substitution."

Some Corollaries to the Above Law.—(1) If one recites his vocabulary in this way:—

seeing "der"	saying "der"	saying "the"
seeing "hund"	saying "hund"	saying "dog"
seeing "haus"	saying "haus"	saying "house"
	etc.,	

he is strengthening not only the new bond (the dotted line in the diagrams above) but also the bond of pronouncing the word when seen. If he learns his vocabulary by merely looking at the foreign word and pronouncing its English equivalent, thus:—

seeing "der"	saying "the"
seeing "hund"	saying "dog"
seeing "haus"	saying "house"

he is strengthening mainly, if not entirely, the new and desired combination.

But even such a procedure does not lead to the best development of one's vocabulary. It leads simply to the connection of "hund" with "dog." If one, on the other hand, should on seeing "hund" say "dog," then "animal," "cur," "Toby," etc., he would give to the foreign word "hund" the *meaning* that attaches to its English equivalent besides connecting the two together.

Gordon has demonstrated this in an experiment in which one group of students studied an Italian-English vocabulary made up of the words in a stanza of a poem. They were permitted to study the vocabulary in any way they pleased for half an hour. The second group spent this half hour as follows:—(a) the poem as a whole was explained, (b) a close translation was given them, (c) the poem was read in Italian, (d) the poem was read in Italian and translated line by line, (e) the group read aloud the poem in Italian, then each member of the group did so and gave a translation, (f) the passage was read in Italian several times. Both groups were tested at the end of the half hour as to their knowledge of the vocabulary, also again a week later. The errors made by the two groups were:—

Test following study, Group I,— 0.58 errors; Group II,—3.83

Test a week later, Group I,—6.30 errors; Group II,—3.50

"Thus the words learned in lists have the advantage at first but lose it later. In addition to a more permanent learning of the

individual words, the second group were able to recite the poem very creditably.[1]

All those who have studied a foreign language have realized the force of the conclusion in this experiment. Foreign words learned as a part of a vocabulary are not learned in the same way as the same words when learned during reading. The word may be known, for example, in the vocabulary but not understood in the text. There are a number of reasons for this besides the one suggested above, but let us consider it alone here. The foreign word has been connected in the vocabulary lesson with an English equivalent, but it has not necessarily been connected with the great wealth of meaning that the English word carries with it. The foreign word may call to mind the English word but the English word called to mind may not then call to mind its meaning since the foreign word is the situation to which we are primarily reacting, not the English equivalent. Under such a condition of affairs two steps are necessary before we can use the foreign word in the translation, (1) think its English equivalent, (2) think the English word's meanings. If the foreign word had been linked up originally not merely with its English equivalent, but also with that word's meanings this trouble would not have arisen. The difference between learning the meaning of foreign words in vocabularies and in actual reading or conversation comes down very largely to the psychological difference, in the first case of merely connecting the foreign word with an English equivalent, and in the second case, of connecting the foreign word with the English word's equivalent. Meaning can then be thought of as made up of the bonds that are attached to a word. The meaning of "paragraph," or "parallax," or "parallel" for any person is the sum total of ideas (bonds) that these words may arouse.

All of this applies to teaching the use of new words. "Condensation," "evaporation," "expansion," "protective coloring," can be taught so that the only response is a series of words (a definition) or they can be taught so that a whole series of ideas follows requiring the writing of a paragraph to express adequately the idea. Demonstrations, experiments, discussions, etc., help here, as contrasted with the mere use of a textbook.

[1] Kate Gordon, *Educational Psychology*, 1917, p. 173ff.

Learning through an Intermediate Association—Associative Shifting

Having considered at some length the process of learning a German-English pair of words through sheer repetition, let us now consider the process when the two words are learned through the use of an intermediate thought, e. g., "hund-hound-dog." Here again we have the same situation-response combinations to start with as before, i. e.:—

Situation		Response
1 seeing hund	⟶	pronouncing hund
2 seeing dog	⟶	pronouncing dog
3 seeing dog	⟶	thinking Toby
4 seeing dog	⟶	thinking animal
	etc.	

But it is evident, in that the individual went from "hund" to "hound," that there was also the situation "hund"—response "hound." In like manner there was also the situation "hound"—response "dog." There is no difficulty attaching to this second additional situation-response combination. But there is in the first case. Why did "hund" call up "hound"? They have never been together before. Can a situation call up a new response of its own accord with no previous connection between them? Yes and no. Certainly not if there has been *no* previous connection between them. "Hund" would never call up "zojk," or "star" for example. But in this case, although the total situation (seeing "hund") and the total response (saying "hound") have never been together before, there are parts of the situation which have been together with parts of the response. The letters "h-und" in "hund" have been together and in the same order as in "hound." Those individuals who *saw* the connection between "hund" and "hound" did so in terms of these common details in the total situation and the response (hound). But some individuals did not see the connection at first, they discovered it after pronouncing "hund." Pronouncing "hund" became the situation which called to mind the English word "hound." And here again the details—sound of "h" and "nd" in "hund" and in "hound" have been together so that emphasis upon "h-nd" could easily lead to "hound,"

in fact more easily than to "hund," because "hound" is a more familiar word than "hund."

We may then explain the cause of these individuals thinking "hund-hound-dog" by stating that they reacted not only to hund as a whole situation, but to the details of that situation, and that the reaction to the details gave them a response which was already linked up with the final response they desired. This process of reacting to a situation in terms of some of its parts comes under the *Law of Partial Identity.* When we have no bond between the situation and a response (or often a very weak bond) we are quite likely to respond to the situation in terms of certain of its parts to which we already have a strong bond. In this case the bond between "hund" and "dog" did not exist or was very weak from only one or two repetitions. We consequently reacted in terms of the details "h-und" instead of "hund" and thought "hound"—the nearest response to "h-und."

There is still another factor to be considered. The Law of Partial Identity explains why the intermediate word "hound" should come to mind. But in terms of this law one would expect also to be reminded of such words as "hand" or "hind" as well as "hound." A careful analysis of what takes place in learning a vocabulary will reveal that many irrelevant words do flash through the mind. But one "dismisses" them immediately, whereas one "holds on" to relevant words. Moreover, far more relevant words come to mind than irrelevant words. Although the chances should be very decidedly against the relevant word, we shall have to explain this phenomenon on the basis that not only does the word "hund" call up "hound" and other similar words, but the word "dog" also calls up words associated with it directly or through partial identity. As the word "hound" is brought to mind by both "hund" and "dog" and words like "hand" or "hind" or "animal" or "Toby" are brought to mind by only one of the two words, the word "hound" is far more likely to come into consciousness than any of the other words. This is an example of what is known technically as the *summation of stimuli.* A reaction is more likely to be made in response to two stimuli than to only one. One may ignore one ticklish sensation but respond violently to two.

Stimulus Substitution versus Associative Shifting

The essential difference between the person who learned that "hund" means "dog" by sheer repetition and the one who learned that "hund" meant "dog" through the intermediary "hound" lies in the fact that the former developed a new bond, whereas the latter utilized bonds already in existence. The former is the simpler method and undoubtedly the more primitive, the latter is characteristic of some of the learning human beings are capable of as distinguished from what animals can do. The most significant difference is that learning a new bond through stimulus substitution requires several repetitions, or else a very strong stimulus, as the sting of a bee, or fright. On the other hand, through associative shifting, a new combination may be learned sufficiently in one repetition so that it will function efficiently throughout life.

Learning by trial and error and by stimulus substitution are the only ways a *new* bond can be formed. But old bonds can be grouped or linked together in very complex ways. And apparently such *reorganizations* may be easily accomplished. (We shall return to this topic in Lesson 15.)

In early life one has few situation-bond-response combinations. Consequently much of one's learning necessarily consists in forming new combinations. This means a great deal of repetition. Children do not seem to mind it; in fact, they enjoy counting, reciting poems, songs, tables, etc. In later life, having now many bonds, one prefers to learn through recombining old bonds rather than developing new ones. It is often stated that children memorize better than adults. That has been disproved by experimentation. Children *cannot* memorize so well as adults, but they *object less* to doing so. Practically speaking, then, they may be said to memorize more easily than adults.

Use of Mnemonic Devices in Memorizing

Many attempts have been made to develop artificial schemes by which one could substitute associative shifting for rote memory. And one or two such systems are constantly being advertised as panaceas for all our difficulties in memorizing names and faces and dates, etc. Here and there are persons who can utilize such

mnemonic devices but with most persons it is as difficult to manipulate the scheme as to learn the material outright. Here is an illustration taken from one of these systems. To begin with, it should be understood that each number is represented by a letter, as, for example, 0 is represnted by S, 1 by P and 3 by CH, etc. Now supposing one wanted to remember that Spain, Macedonia, Africa, Carthage, and Asia Minor were added to the Roman Empire in 130. Put down the initial letters of the five names, i. e., S M A C A M. This calls to mind "smack 'em," then "smack the lips," then "luscious peaches," and that gives us "Pea CHe S," or 130.

Whether one can remember dates more easily by such devices than by memorizing them outright depends on the individual almost entirely. In some cases one can utilize the steps employed by another, as in the case of learning the Chinese symbol for "well," but ordinarily if one does not originate the steps himself they are of little or no value.

The Effect of Position upon Learning

The first and last two or three pairs of words were learned much more quickly than the pairs in the middle of the list of twenty-five. This is a common occurrence under such conditions. Apparently in learning a vocabulary, for example, such as:—

faire	—	do
chien	—	dog
mouche	—	fly
pied	—	foot

we not only respond with the word "do" to the situation "faire" but also to the situation "first word in the list." Likewise in the case of "chien—dog" we not only pronounce the word "dog" in response to the situation "chien" but to the situation "second word in the list" and very likely also in such a case to the situation "do," since "dog" is so similar to "do." It is apparent that these "position" situations aid us materially in committing a vocabulary to memory but later on when "faire" is met in a French story it may not be reacted to because the element "first word in a vocabulary" is missing. Learning items in terms of

"position" is a risky performance if the items are to be met singly later in life.

The Prompting Method

What we want in life is to be able to give the English equivalent of the foreign word when it is encountered (and vice versa). Through the prompting method we are drilled in reacting to the single words just as we shall wish to do later in life. For that reason it is superior to other methods of learning vocabularies in which we are drilled to react more or less differently from the way we need to respond. The best method of acquiring a vocabulary is through speaking the language and reading it, just as one learns his native tongue. If one must memorize vocabularies the best method is to prepare small slips of paper. On one side write the English term and on the other side the foreign equivalent. In studying the vocabulary pick up the slip of aper, read off the term on one side and recall its equivalent. If this can not be done, turn the paper over and repeat the two terms several times together. After thus going through the list, shuffle the slips of paper and repeat the process. In this way the "prompting method" can be used by one person, and all associations with position are eliminated.

LESSON 12

WHAT ARE THE LAWS OF RETENTION?

We have all had the experience of not being able to remember a fact or do a certain stunt which we have been able to do previously. We say we have forgotten. Let us look into this matter of forgetting and see of what it consists.

In Lesson 4 the alphabet was repeated forwards twenty times and backwards twenty times and in Lesson 10 a vocabulary of 25 Spanish-English words was memorized. These two experiments will now be repeated in order to discover how much has been retained and how much has been forgotten. (Obviously, if S practices before coming to class the experiment will be ruined.) A third experiment is concerned with the extent to which we are able to retain what has been presented to us for a very short interval of time.

(Do not get excited because there are three experiments to do. They will not take very long. If necessary you can easily do the third experiment outside of class upon some friend.)

Experiment I. To What Extent Does One Retain Learning to Say the Alphabet?

Apparatus.—Watch with second-hand.

Procedure.—Have S (the same individual who was S in the Alphabet experiment in Lesson 4) repeat the alphabet (1) forwards and (2) backwards twenty times each. Record the time for each trial.

Results.—Plot on one sheet of co-ordinate paper the curve (1) of learning the alphabet forwards and (2) backwards as obtained in Lesson 4 and (3) the curve of relearning the alphabet forwards and (4) backwards as obtained here. (The results should be worked up after completing the next experiment.)

Experiment II. To What Extent Does One Retain A Vocabulary?

Apparatus.—The same Spanish-English vocabulary used Lesson 10.

Procedure.—Use here the same S as in Lesson 10. E prepares another blank similar to the model in Lesson 10 and writes in the 25 Spanish and English words. He supplies S with a list of the 25 Spanish words. There will be no initial reading of the vocabulary to S as was done in Lesson 10. When E and S are ready S will commence at the top of the list of Spanish words and pronounce the first Spanish word and then attempt to give the English equivalent. (1) If he does so, E says nothing and S passes to the second pair immediately calling out the Spanish word and giving its English equivalent, etc. (2) If S gives an incorrect English word, E will write that word in Column 1 opposite the appropriate Spanish word, and prompt S as to what the correct English word is. S then pronounces the next Spanish word, etc. (3) If S makes no reply within 5 seconds, E marks an "x" in Column 1 opposite the Spanish word, and prompts S as to the correct English word. Then S pronounces the next Spanish word, etc.

Repeat the above procedure trial after trial until S can give correctly the English equivalent to each of the 25 Spanish words without error and without waiting more than 5 seconds in any case.

Results.—Plot (1) the curve of learning the vocabulary as obtained in Lesson 10 and (2) the curve of relearning as obtained here.

Experiment III. How Many Digits Can One Repeat Correctly Immediately after Hearing Them (Memory Span Test)

Apparatus.—List of digits given below.

Procedure.—Using the series of digits given below, read a short series to S at the rate of one digit per second. Take the utmost care to read so as to ensure even tempo, clear articulation, and entire absence of rhythm.

While E is reading the list to S the latter should keep his mouth closed and should not repeat the digits to himself. Directly at the conclusion of the series, let S repeat as much as possible of what has just been read him. (In testing young children E should record in writing S's reproduction; with older individuals it is advisable to have S write down his own reproduction. In this case S should indicate each omission by a dash or a blank space, thus for the series, 9, 4, 7, 3, 5, 8, 6, the reply is 9, 4, 7,—, 8, 5, 6, if S is unable to remember the fourth digit and has interchanged the fifth and sixth digits.)

After having read a short series to S and having obtained his correct reproduction, read him a longer series. If he is again correct, read the next longest, and continue until he makes errors. Suppose his first error is with a series of seven digits. Then secure in all three trials with the series of six digits, three with seven digits, and three with eight digits. In other words discover the longest series that S can reproduce correctly three times, also the shortest series that S cannot reproduce correctly at all in three trials, as well as three trials with any series of intermediate length.

Credit S with his best score, i. e., if he responded correctly to all three of the 5's, to only one of the series of 6's, and no times to the series of 7's; then credit him with a memory span of 6. A correct answer means that the digits are not only all repeated but they are repeated in the original order.

MEMORY SPAN TEST

2. 7-3	1-6	8-5
3. 2-9-4	8-3-7	9-6-1
4. 5-1-8-3	9-2-7-4	3-8-2-6
5. 4-7-3-9-2	6-4-1-8-3	2-8-3-7-9
6. 8-5-1-7-2-9	2-7-9-3-8-1	9-4-1-7-2-8
7. 2-9-6-4-8-7-5	9-2-8-5-1-6-4	1-3-8-5-9-7-4
8. 4-7-2-9-5-8-1-6	7-1-8-3-6-2-9-5	4-6-1-5-8-2-9-7
9. 7-2-4-9-3-8-6-1-5	4-7-5-2-9-3-6-1-8	2-5-9-3-8-1-4-7-6
10. 8-3-9-5-1-6-2-7-0-4	7-4-0-2-5-1-9-3-8-6	2-6-1-4-0-7-3-8-5-9

In case of any mistake, additional series can be obtained by reading the above lists of digits backwards. In retesting an individual this should be done. Let each partner act as S in this experiment, if there is time.

Results.—Record the memory span of each partner.

Interpretation.—Answer the following questions based on the three experiments.

1. How much do you calculate S forgot during the interval of time between the first and second alphabet experiments? Between the two vocabulary lessons?

2. On the basis of the first two experiments and your genera knowledge, do you think that a person who had studied Latin two years would ever forget the first conjugation? Get as good evidence for your view as you can.

3. In what way is the memory span test related to the two experiments on retention? Explain. In what ways do the two differ?

4. According to data furnished by Stiles,[1] children have memory spans, as given below. In the second and four columns are given the average memory spans for boys and girls and in the third and fifth columns are given the memory spans that the poorest child of the best ¾ of each class had. The data are based on records from 751 boys and 834 girls.

	Boys		Girls	
Age	Average	Division between best ¾ and poorest ¼	Average	Division between best ¾ and poorest ¼
6	5.3	5	5.5	5
7	5.6	5	5.6	5
8	6.3	6	6.1	5
9	6.5	6	6.6	6
10	6.8	6	6.4	6
11	6.6	6	6.9	6
12	6.9	6	6.9	6
13	6.9	6	7.2	7
14	7.2	6	7.1	6
15	7.2	7	7.2	7
16	7.4	7	7.2	7
17	7.5	7	7.7	7

[1] C. W. Stiles, Memory Tests of School Children, *U. S. Pub. Health Service*, Reprint No. 316, Dec. 24, 1915.

Gates[1] reports the following distribution for 163 college students in visual and auditory memory span. (His results are converted here into percentages, i. e., 0% of college students have a memory span of 4 with visually presented material, 1% have a span of 5, 9% of 6, 18% of 7, etc.)

No. of digits	4	5	6	7	8	9	10	11	12
Visual presentation........	0	1	9	18	39	21	8	2	2
Auditory presentation......	0	7	14	18	35	18	6	1	1

In the light of the figures in these two tables and your own records what do you suppose is the relationship between proficiency in memory span and (1) age, (2) general intelligence?

5. Would you expect as good school work from a child of 12 years of age who has a memory span of 5, as you would from a child with a memory span of 7? Explain.

6. Would knowing the memory span of an individual help you at all in advising him as to the kind of job he should attempt to get? Consider such jobs as these for a girl: saleswoman in a store, cook, telephone operator, stenographer, machine operator, milliner, book-keeper, teacher.

Write up these three experiments following the regular outline and hand in at the next class-hour. Do not forget the heading "Applications."

[1] A. I. Gates. The Mnemonic Span for Visual and Auditory Digits, *Jour. Exper. Psychol.*, Oct., 1916.

LESSON 13

RETENTION (continued)

The subject of retention has to do, of course, with the permanency of our learning. We have seen that in learning we develop a new bond between a situation and its response. We are here interested in discovering whether this bond remains permanently in the same condition as time goes on. When we learned the alphabet backwards we formed new bonds, for example between N and M and between U and T. After an interval of time has elapsed will these bonds function in the same way as they did just after they were formed?

Let us consider the data from a subject who did the alphabet experiment first on June 17 and repeated it again on June 23. His data are as follows:

Trials	Time, June 17	Time, June 23
1	26.0 Sec.	17.2 Sec.
2	22.0 Sec.	16.2 Sec.
3	22.0 Sec.	17.3 Sec.
4	18.8 Sec.	15.4 Sec.
5	17.8 Sec.	11.1 Sec.
6	19.8 Sec.	12.0 Sec.
7	19.0 Sec.	10.0 Sec.
8	18.8 Sec.	10.0 Sec.
9	26.4 Sec.	14.4 Sec.
10	28.4 Sec.	9.0 Sec.
11	16.0 Sec.	15.3 Sec.
12	16.0 Sec.	10.0 Sec.
13	16.4 Sec.	10.0 Sec.
14	12.4 Sec.	9.2 Sec.
15	11.8 Sec.	10.0 Sec.
16	14.4 Sec.	10.0 Sec.
17	9.6 Sec	8.2 Sec.
18	14.4 Sec.	8.2 Sec.
19	11.4 Sec.	8.0 Sec.
20	11.4 Sec.	9.0 Sec.

His last trial on June 17 required 11.4 seconds and the first trial six days later took 17.2 seconds. We can say then that he has

forgotten this performance to the extent of 5.8 seconds (17.2 – 11.4). But this does not mean that he has lost all that was gained from the twenty trials. If all had been lost it would have taken him 26 seconds on the first trial on June 23d, as it took him that long on the first trial of June 17.

As it was, he retained this performance to the extent of 88. seconds (26.0 – 17.2). Clearly, then, *one does lose during an interval of time part of what one was able to do, but one does not lose all.*

Or looking at these data in another way, this individual on his eleventh trial on June 17th beat his first trial on June 23d. We might say then that he lost the effect of 10 trials during the interval of six days, i. e., the effect of the 11th to the 20th trial. But on the other hand the 10th trial on June 23d (9.0 seconds) beat the best record on June 17 (9.6 seconds). That is, apparently only 10 trials were needed the second day to accomplish what was not accomplished in twenty trials on the first day's practice.

To sum up, then, this individual retained during the six days the effect of the first ten out of the twenty trials or an increase in rate of 8.8 seconds (26.0 – 17.2). He lost the effect of the last ten trials or a decrease in rate of 5.8 seconds (17.2 – 11.4).

As for the relationship between what one loses and what one retains, that is found to be dependent on several factors, the chief of which is obviously the amount of practice which entered into the previous learning. Without doubt the more thoroughly one learns a thing originally the better one can remember it. Hence we say that *retention is dependent upon amount of practice* or that *retention is dependent upon strength of the bond.*

The Effect of Time Interval upon Retention

The results outlined above are characteristic of what one retains and what one loses during an interval of time. If the interval is very short, one of course retains proportionately a great deal of what he has learned and one loses very little. If on the other hand, the interval is very long, the relationship is reversed.

Now it is natural to suppose that the longer the interval of time the more one would forget. If one lost 10% during an interval

of an hour, then one would lose 20% during a two-hour interval, or 30% during a three-hour interval. But if this proportion is carried further one would lose 100%, or all, in 10 hours and 110% in 11 hours, which is, of course, impossible. Apparently this is not the correct conception. The rate of forgetting is not proportional to the time that has elapsed. It is actually very rapid during the first few minutes and becomes less and less as time goes on. In Plate IX are given two retention curves, one worked out by Ebbinghaus[1] in 1885, and the other by the writer[2] in 1913.

In Table I are given the data on which these curves are based.

TABLE I.—PER CENT. RETAINED AFTER VARYING INTERVALS OF TIME

Interval of Time	Results of Ebbinghaus, Per Cent.	Results of Strong, Per Cent.
15 Seconds	....	84.6
5 Minutes	....	72.7
15 Minutes	....	62.7
20 Minutes	58.2	....
30 Minutes	....	55.5
1 Hour	44.2	57.3
2 Hours	....	47.2
4 Hours	....	50.6
8 Hours	....	40.6
8.8 Hours	35.8	....
12 Hours	....	41.1
1 Day	33.7	28.8
2 Days	27.8	22.9
4 Days	....	19.3
6 Days	25.4	....
7 Days	....	9.6
31 Days	21.1	....
42 Days	....	6.3

From the figures of Ebbinghaus a person retains approximately two-thirds of what he learned after 20 minutes, one-half after an hour, one-third after 9 hours, and but one-fourth after 2 days. The writer's figures show a somewhat greater amount retained after very short intervals of time and a somewhat smaller amount after long intervals of time. But the principle remains the same

[1] H. Ebbinghaus, *Ueber das Gedächtnis*, Leipzig, 1885.

[2] E. K. Strong, Jr., The Effect of Time-Interval upon Recognition Memory. *Psychol. Rev.*, Sept., 1913.

in both. *We forget very rapidly at first and then more and more slowly.*

Retention of Motor Habits.—The curves of retention given in Plate IX apply to the retention of habits that have been developed with relatively few repetitions. When we turn from such performances to others, such as dancing, skating, typewriting,

PLATE IX.—Showing effects of various intervals of time upon retention. (Solid line—results on recall memory by Ebbinghaus; dotted line—results on recognition memory by Strong.)

handwriting, etc., we find that there is no such rapid forgetting as these curves of forgetting suggest. After one has once learned to ride a bicycle one will forget relatively little during an interval of years in which the bicycle is not touched. In such a case a person has not only learned to ride a bicycle but he has ridden it time after time until the habit has been, as we technically say, *over-learned* enormously. The extent to which we retain a habit, whether it be of reciting a poem, playing a piece on the piano, or tying our necktie depends then (1) on the interval of time since we last practiced the habit, and (2) on the extent to which we practiced the habit originally. We may draw the moral from

this section that learning any habit to the extent that it will function correctly means that we know it at that time, but only much practice over and above such learning will insure our knowing it months or years later.

Physiological Basis for Retention

The term "bond" has been used in this course to cover the nerve connections involved in learning. Later on certain phases of the nervous system will be discussed. At present only one new conception need be considered. It is that a nervous current encounters resistance in flowing over a nerve; and the more frequently such a current flows over a particular nerve the less the resistance.[1]

A habit or memory is today conceived of as due primarily to the chemical change in the nerve connections whereby the resistance is lowered, thus permitting the nervous current to flow in this particular direction rather than in some other direction.

Consider the analogy in Lesson 9 of Q, blindfolded, learning to go in a certain direction over a snow-covered field, depending first on signals from P and later on the "feel" of the path he has previously formed as distinguished from the untrodden snow. The analogy was presented to show how a smoothly running habit could develop from mere random movements. We can liken the resistance encountered in walking through the snow to the resistance offered to a nerve-current by a little used nerve. And we can liken the decreasing resistance encountered as the path develops in the snow to the decreasing resistance made to a nerve current by a more and more used nerve. At first it makes no difference which way Q travels through the snow, the resistance is equal in all directions. Later Q can travel more easily along the path he has previously formed than in any other direction. Likewise in responding to a new situation (e. g., the attempt to wag the ears) the resistance is great over every possible pathway and there results either no response at all or all sorts of random movements (e. g., frowning, winking, twisting the mouth, raising the scalp, twitching of the toes, etc.). Later the situation produces the one response (moving the ears) and no

[1] See lesson 57, for more detailed discussion, under the heading of Synapse.

other, because the resistance over the nerves connecting situation and response is lower than any other pathway from the situation to any other response. *The new habit is dependent on the relatively low resistance of the nerves which connect situation and response as compared with the resistance of the nerves which connect the situation with any other response.* The same thing is equally true of retention (of memory). In fact, retention is synonymous with lowered resistance over nerves. The resistance is lowered by use and increases again through disuse.

At one time memory was thought of as the storing of nerve cells, similar to storing a storage room with supplies. Such a conception is false. Memories, or habits, are nothing more nor less than expressions of the fact that certain responses will now follow certain situations because of low resistance of the nerves comprising the bond.

With these facts before us we can readily see the futility of supposing that a "memory" can be recalled at any time. A "memory" in this sense doesn't exist. All that actually exists is a system of conduction pathways with low resistance. If the former situation is encountered the proper response will follow because of this low resistance. But the response (memory or habit) will never appear unless the original situation, or a very similar situation (Law of Analogy) is presented.

Relearning

It is clear from what has been established that as soon as practice in learning anything ceases one commences to forget. And, moreover, that one will forget very rapidly at first and then more and more slowly. We should expect accordingly that at the commencement of every writing lesson, every music lesson, every sort of lesson, the beginner will not do so well as he did at the end of the previous lesson. The first few minutes will be spent in *relearning* what has been lost during the interval. It is a common observation that it takes a few minutes in which to warm up to a subject. The athlete finds this to be the case in physical work. One should realize that he cannot do his best work at the start, and not get discouraged but quietly and carefully go over the performance a number of times until he has relearned what

he has temporarily lost. Then he can expect to be doing his best work and to commence trying to beat his previous record—to improve his accuracy and his speed. The writer has found this to be very true in his own case in typewriting. If he endeavors to go at full speed when he begins to write he only makes mistakes and is apt to continue to make more mistakes throughout his entire period of work. But if he will content himself with going slow for a few minutes at the start he can soon go ahead at full speed making but few mistakes.

(Some writers maintain that there are two factors involved here—one due to *relearning* and another to *warming-up*. In studying the rate at which individuals work in all sorts of industries it is clear that they work more slowly early in the morning than later in the day. This phenomenon affords some evidence for a "warming up" factor related to getting started going in the day. And likewise there may be a similar tendency related to starting working at any particular task, besides that involved in "relearning." Very often we do not feel at all in the mood, as we say, and after working for some time become deeply interested and lost in the work. Possibly this change is due to other causes than relearning, i. e., bringing the bonds which are needed for our work up to their highest state of efficiency. The writer, however, believes that the term "relearning" covers most, if not all of these cases, except in the case of the daily warming-up phenomenon.)

Primary and Secondary Retention

A mental process continues to remain in consciousness for a short interval of time. For example I look up a telephone number, lay down the book, put the receiver to my ear, and after hearing from central, say, "Hemlock 2173-L." Central in a moment replies "Line is busy." I hang up and decide to wait a few minutes and then discover the number has slipped from my mind. The retention of the number from the time it was seen in the book until it was recited to Central is an example of *primary* retention. The number was really at no moment out of my mind. But as soon as it had been given to Central, it was dismissed. Now if I could call it to mind again, as I can my

own house number, that would be a case of *secondary* retention or recall. The laws for forgetting so far discussed refer to secondary retention, a term which covers both recall and recognition memory. Primary memory, on the other hand, persists for but a few seconds. That it seemingly lasts longer is due to the fact that we keep repeating the contents over and over and so continue its existence in consciousness.

One of the most interesting facts concerning primary memory is given us in such an experiment as that of Memory Span. Here is measured the number of digits that can be retained in primary memory. An average adult can so hold seven digits. Children differ from adults in this respect. A two to three year old can retain but two digits. A little later the child can repeat three digits. And so as he grows older he acquires a greater and greater ability along this line. Defective children without normal mentality often show marked inferiority in their memory span. A child of twelve years of age with a memory span of four is most likely to be defective. Recently the writer was asked to help a young woman get a job. She was about 18 years old but had a memory span of four. Other tests showed her to be but 9 years old mentally. The failure to reach adult proficiency in memory span would shut her out of such jobs as a telephone operator or stenographer, for in both these occupations there is decided need for primary retention. In fact her low memory span emphasized the uselessness of her attempting to do any work which required attention upon a number of details at the same time. Running a simple machine or selling goods in a five and ten cent store would be as complicated tasks as she could do. And in fact, these were the only jobs this young woman had ever been able to hold more than two weeks.

One of the most useful tests that can be made on children is this one of the memory span. When poor work in school and low memory span are found together, it is quite likely to mean that the child is dull and cannot do good work. When, on the other hand, poor work and a good memory span are found together, it is more than likely that the child is not trying sufficiently, or has become discouraged in his work for some reason or other, or has been sick and absent and missed important points in his lessons. One cannot diagnose all of a child's condition with this test, but it is a good one to start with.

Methods Employed in Studying Retention

It might be worth while to digress a moment and consider the *methods* employed in the two investigations quoted above. Ebbinghaus made up lists of 13 nonsense syllables such as, neb, pid, raz, tud, cor, etc. He memorized seven such lists one after the other to the degree that he could recite the lists once correctly from memory. He then relearned the seven lists after intervals of 20 minutes, 1 hour, 8.8 hours, 1 day, 2 days, 6 days and 31 days. He kept a record of the number of repetitions that were required to learn a list originally and then relearn it. Suppose he required 10 repetitions to learn a list originally and after two days he required 7 repetitions to relearn a list. It is clear that he has saved 3 repetitions (10 − 7) and has lost 7 repetitions after two days as compared with his original learning. Dividing the number of repetitions which he has saved (3) by the number of repetitions which he was originally required to make in learning the list (i. e., 10) we have 3/10, or 30%, as the amount saved or retained after an interval of two days. (This is a comparable method to the prompting method discussed in Lesson 11, and is technically known as the *learning* and *saving* method.)

In the case of the writer's investigation he employed lists of twenty words. S read the list through just once. Then after one of the thirteen intervals of time employed (e. g., 15 seconds, or 8 hours, or 7 days) S was given a list of 40 words containing the original 20 words and 20 new words all mixed in together. S was required to go through the list and mark the words he recognized as having been in the original list. The percentage recognized gave the amount retained. (This is known as the *recognition method.*)

The two investigations were based on two different types of memory. In the case of Ebbinghaus' work S had to *recall* the list. In the case of the writer's investigation S had merely to *recognize* the words he had previously seen, to distinguish between the new words and the old words. But in both cases the extent to which S could recall or recognize was due to the *strength of the bond* that had been formed during the learning. In the next chapter we shall take up the matter of the strength of the bond and consider it more fully.

Summary

The principal points considered in the lesson are:

1. Retention is dependent on (*a*) the strength of the bond and (*b*) the interval of time which has elapsed since the last practice.
2. We forget very rapidly at first and then more and more slowly.
3. Only through a great amount of practice can one hope to retain a memory or habit over a long interval of time.
4. Relearning at the start of any practice is to be expected.

The following minor points were also touched on.

1. The physiological basis for retention.
2. Primary versus secondary retention.
3. Use of memory span test in diagnosing an individual's capacities.
4. The "learning and saving" method of studying retention.
5. The "recognition memory" method of studying retention.
6. Recall versus recognition memory.

LESSON 14

WHAT FACTORS AFFECT THE STRENGTH OF A BOND?

From our experiments on the learning process we know that practice (repetition) results in our doing the task better and better. This means that the bond or bonds connecting the situation and the response become stronger and stronger. And from our study of retention we have seen that lapse of time in which no practice occurs results in our losing some of our efficiency in the task. This means that such lapse results in a weakening of the bonds connecting the situation and response. Clearly then, use strengthens a bond and disuse weakens it.

Let us turn now and see if there are still other factors which affect the strength of a bond.

The class-hour will be devoted to a demonstration experiment. Each member of the class will consequently act in the role of subject. Carry out the instructions of E as conscientiously as possible but do not worry if you find you are not retaining all that is presented. No one can. Simply endeavor to pay attention throughout the entire experiment and to absorb as much as possible.

The total results as obtained from the class will be given to you before leaving, together with such details of the procedure as are essential for you to know. Write up the experiment in the usual manner, i. e., under the headings: The Problem, Apparatus, Procedure, etc. Work up the data as it seems best to you, bringing out the important facts and principles which are illustrated. Hand in your report at the next class-hour.

NOTE FOR INSTRUCTOR.—Instructions regarding giving this class experiment are given in *Instructor's Manual*.

LESSON 15

FACTORS AFFECTING THE STRENGTH OF A BOND (continued)

Six factors will be considered in this lesson as affecting the strength of a bond. They are—repetition, intensity, interference, reorganization, recency, and effect. Data on the effectiveness of the first four were obtained from the experiment in Lesson 14. The factor of recency or lapse of time since learning was studied in Lessons 12 and 13. The factor of effect of satisfaction and dissatisfaction will be considered for the first time.

FACTORS THAT STRENGTHEN A BOND

A new bond is *formed* through trial and error or stimulus substitution. It may be *strengthened* in one of three ways:—

Repetition.—The fact that repetition strengthens a bond has been clearly shown in all of the preceding experiments. In the last experiment when a combination was shown once it was remembered by 5% of the individuals, when shown twice it was remembered by 9%, and when shown three times, by 41% of the individuals. These figures show the value of repetition. It should not be assumed that they represent what would happen under other conditions. The more items shown the weaker is the relative value of repetition. If there were but ten addition combinations to learn a few repetitions would suffice to fixate them. But as there are many more than that very many more repetitions are necessary. The figures in the table, however, do illustrate the value of repetition.

Intensity. (*a*) *Intense Stimulation.*—Of two repetitions the one that is the result of the greater stimulation will result in the greater development of the bond. A tiny burn on the skin will not make us leave the hot radiator alone like a large burn. In physiological terms the release of a large amount of nervous current by stimulation of the sense organs will more materially

affect the nerve connections than will the release of a small amount of current. This is the basis for the factor of intensity as it affects the strength of a bond. In our experiment there was no adequate example of a violent stimulation. If there had been that combination would have been exceedingly well remembered. This might have been accomplished in the experiment by having exposed a combination twice or three times as long, or by having the instructor call out the combination as he showed it. But neither of these is comparable with the intense stimulation we experienced when we caught a bee the first time. Throughout life that one experience of being stung is remembered and we markedly differentiate bees and other insects. The artificial production of great stimulation is difficult to accomplish in influencing others. It is done sometimes through punishment. A better example is where a parent or teacher arranges matters so that the child will get, for example, a slight electrical shock in order to teach him to leave wires alone.

(*b*) *Contrast.*—A stimulus will be reacted to more intensely if its surroundings contrast sharply with it. Thus an ordinary electric light will barely be noticed among fifty others. But if the other forty-nine are made to glow very brightly or very dimly, then it will be singled out. The first and last elements in a series are often noticed more than those in the middle and being noticed more are better remembered. This was the case in learning a vocabulary, but not in the experiment in Lesson 14. The contrast factor of difference in background is sometimes effective, though not always. The intensity gained through contrast alone seldom amounts to more than a few per cent. Men and women do not usually distinguish between contrast and other factors and so attribute to it much more value than is due it. For example, if one is looking for a certain hotel and a light flashes on and off around the hotel name, the name is seen much more quickly and the flashing light is given the credit quite properly. But if one were not looking for the hotel, the hotel name would be ignored almost as much as though the light were not there. The efficiency of the flashing light is due to the contrast effect plus the desire to see the name. And the latter element is the more important of the two. Possibly the true situation is this. If only one or two items are made prominent by contrast then they are noticed to a considerable extent and so

remembered. If many items are made prominent, the intensity factor becomes much less valuable. Contrast the value, for example, of one colored advertisement in The Saturday Evening Post as against twenty or one hundred.

Prominence (intensity or contrast) may aid in learning because the item is singled out and noticed more than the others and, therefore, remembered better.

(c) *Emotional Excitement.*—A bond is also strengthened by emotional excitement. If a child is told that punishment will result if he does not do as directed, he is more likely to remember than if the emotional fear were not aroused. Incidents seen in a movie are surprisingly well remembered in contrast to what is learned in school. (This topic is included here, in order to round out this discussion. It will be considered at greater length, beginning with Lesson 31.)

Effect. (a) *Satisfaction.*—Thorndike[1] states that when we make a response to a situation and feel satisfied or pleased, then the bond is strengthened because of the satisfyingness. When the response is followed by dissatisfaction, the bond is weakened because of the dissatisfyingness. Moreover, the closer or more intimate the relationship between the performance and the satisfaction or dissatisfaction the more pronounced is the effect upon the strengthening or weakening of the bond.

Effect influences learning because the resulting satisfaction or dissatisfaction establishes, first, a standard in terms of which successful movements are repeated and unsuccessful ones discontinued, and second, the organism continues a process which gives him pleasure and discontinues a process which gives him displeasure. All of Watson's[2] experiments in which he rewards the correct movement and punishes the incorrect ones bear this out. His rats choose the former because they are so constituted that they go toward food and not away from it, avoid an electric shock instead of seeking it. We develop habits which result in our being able to do what we enjoy and we do not form habits which result in unpleasantness.

The Law of Effect which we add to our five other factors means, then, that learning is dependent (1) on the presence of some standard which determines when the learning process (random

[1] E. L. Thorndike, *Educational Psychology*, 1913, Vol. II, p. 4.

[2] J. B. Watson, *Behavior*, 1914, Chapter VII.

movements) is ended, (and it is ended when we obtain a more satisfactory state than before, or are completely exhausted) and (2) on the fact that we will continue pleasant responses but will not continue unpleasant ones.

The second thought in Thorndike's statement is also important. The sooner after the movement has been made that we know we are on the right track or on the wrong track (i. e., experience satisfaction or dissatisfaction), the greater is the value of this factor in learning. If a child has spelled incorrectly or disobeyed his mother then immediate punishment is far more efficient than delayed punishment. In fact, in teaching animals or small children only *immediate* praise or punishment is worthy of consideration. As one grows older one can profit from satisfaction or dissatisfaction after much longer intervals between the execution of the act and the resulting realization that one has performed the act correctly or incorrectly. Nevertheless the shorter the interval of time the greater the value of this factor of "effect." Conscientious high school or college teachers of English labor for hours making detailed corrections in grammar, etc., in themes and then wonder why the same mistakes are made again and again. One reason is undoubtedly that the correction follows so long after the act. Immediate correction would accomplish wonders here as contrasted with this long delayed arousal of dissatisfaction. Grammar school teachers, on the other hand, require each child to write his lesson on the board and call upon him to defend it before the class. Here the interval between execution and realization is reduced to a minimum.

Factors That Weaken a Bond

Lapse of Time.—Experiments in relearning the alphabet and vocabulary have clearly demonstrated that we forget, that our bonds do deteriorate if they are not used. The more recently we have performed an act the better can we do it again. (This factor is often entitled, "Recency" instead of "lapse of time.")

Interference is a factor in affecting the strength of a bond. We have here the formation of two bonds connecting the same situation with two different responses. As both responses can not be made at the same time, when the situation is presented, no response results. If a child in reciting the multiplication table

says 9 × 7 is 63 and later says 9 × 7 is 67, when called on by the teacher for the answer to 9 × 7 he will make no reply in most cases, or wildly guess. To strengthen a bond requires then that no competing bonds be formed at the same time. After a bond has been well developed, however, a new bond may be developed without any great injury to the old one. Herein lies one of the reasons for teaching the addition combinations first and then the multiplication combinations afterwards. If they were taught at the same time there would be great confusion. After the first have been well learned then the latter can be readily learned. But even here it is an advantage to keep them apart in the school work until both are fairly well developed.

"Distraction" is another phase of interference. The playing of a piano in the next room interferes with one's study. Here there is competition between situations, i. e., "music" and "algebra" rather than between the responses to the same situation.

Effect. (*b*) *Dissatisfaction.*—Just as a satisfying effect from the performance strengthens the bond, so a dissatisfying effect weakens the bond. This law explains how new styles of dress and manner are learned with such surprising rapidity and then as quickly dropped. It is a factor that underlies the self-conscious and suggestible attitudes discussed in Lesson 9. When in those attitudes one is responding to any indication of approval or disapproval from within oneself or from another, and one is is reacting to such, even more than to the problem confronting him.

Reorganization

Reorganization is not a factor in the development of a really new bond, of course, but from the practical point of view of learning it is a most important factor since a great deal of our learning consists of linking a situation with a response by means of already established bonds. To link "hund" with "dog" by means of the element "hound" is just as truly learning as to connect them directly together: so also to learn "C is 100" in the experiment of Lesson 14 through linking up "C" with "Roman notation." This type has been called associative shifting, as the learning involves a reorganization or shifting of already formed bonds or associations.

The old, old adage in education of "*going from the known to the unknown*" in teaching emphasizes the value of this type of learning for when we start in to teach a new thing and first consider all of its phases which are already known, the child connects it up with old bonds and so utilizes them in learning.

Novelty.—Human beings are particularly interested in a complex stimulus which stimulates a combination of old bonds that have never before been stimulated together. For example, the writer was lecturing one hot day just after lunch, upon this subject and the students gradually became more and more listless and inattentive. Now either contrast or reorganization could be utilized to get their attention. The writer could have talked louder, or paced up and down the room, or written on the board, etc. All these would be contrast effects and would have some effect. Instead he described in his ordinary tone of voice an advertisement entitled something like this, "How does ——— (an actor) make a cat yawn on the stage every night?" Immediately, the class was awake and paying attention. Why? Because a situation made up of details with very old and well developed bonds was presented. And the combination was new. The words "cat," "yawn," "stage," and "night," have very strong bonds. Such a novel reorganization of old, familiar situations will always attract attention (i. e., be responded to) and will easily be retained.

There is a profound difference between learning *a new thing* and learning *a new combination* of old things. The former is most uninteresting and difficult to "get hold of," despite the popular notion. Consider how uninteresting the first lesson in physics or algebra was, or how little you read of foreign countries you have not visited. On the other hand, consider with what interest the expert milliner reads over technical discussions of the latest styles, or a botanist seizes upon a new flower, or you read descriptions of places you have visited. The average visitor to Niagara Falls or Yosemite is very often disappointed at first. The scene is too new to make an impression. But as he continues to drink in the scene for several days it grows and grows on him because he has commenced to link it up with his other experiences. A big dog is a contrast to an ordinary sized dog. It arouses some notice and is more likely to be remembered than the average dog. But a dog with a pipe in his mouth is a

novelty—a new combination of two old familiar things (dog and pipe). That dog draws a crowd.

In teaching, in advertising,[1] or in any field where one desires to create an impression and have it retained, that impression can be most easily and efficiently accomplished by linking up the parts of the new impression through the use of old bonds, old ways of thinking. A novel presentation (i. e., one capable of reorganization by the learner) accomplishes most. And it is efficient just in the degree that the old is utilized by the learner in connecting the new together. Contrast effects, such as increasing the size of the type in an advertisement or the size of the advertisement itself, or giving it a colored background, or yelling at the class, or writing an assignment in pink chalk, or wearing a florid necktie, do not aid particularly in developing the new bonds presented in advertising, teaching, or salesmanship, and sometimes they positively interfere through distraction.

When the lesson can only be learned through the development of *new* (actually new) bonds, then drill (repetition) is the only solution. This does not mean that the lesson need be recited over and over in the same way. Proper drill is that in which the essential part is repeated again and again until mastered, but in which the repetition is carried on in various ways so that the learner does not tire of monotony, but is stimulated by the changes.

[1] See H. L. Hollingworth, *Advertising and Selling*, 1913, Chapters V and VI for an extended discussion of the factors of contrast and novelty as utilized in advertising.

LESSON 16

HOW TO REMEMBER

We have now some idea of retention, of how habits and memories are retained from the time they were originally developed until needed again. We have seen that these habits fade out as time goes on. We have seen that they are developed and strengthened by such factors as frequency and intensity and are influenced by such factors as interference, reorganization, and effect.

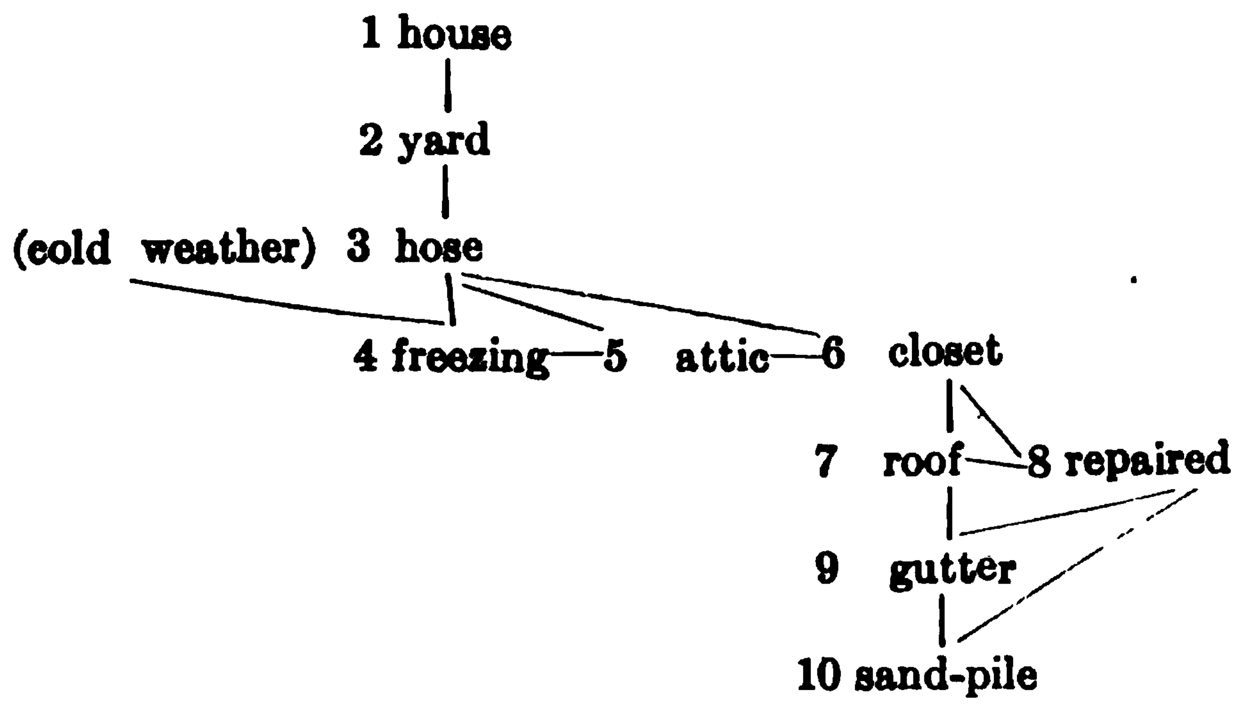
We are now ready to consider the problem of *reproduction, of how we may remember efficiently.*

It is clear that the strength of the bond must be a very important factor in efficient reproduction. If "6 by 7 equals 42" has been said but once, the bond necessarily is very weak and it will not be remembered as it would if the equation had been repeated twenty-five times.

In this lesson we want to emphasize another factor affecting reproduction,—a factor which is just as obvious and just as fundamental as the one concerning the strength of the bond, but a factor which has been grossly overlooked in most psychologies and in the consideration of this problem by educators. Carry through the following experiments and then endeavor to formulate into a law what efficient reproduction presupposes.

General Directions.—Read over and perform each part before going on to the next part.

Part 1.—Have S call out 30 words as fast as E can write them down. Record the time required to call out the 30 words. Then obtain from S a careful analysis of just how each word led to the next word. The analysis can take this form.



The diagram illustrates that "house" called up "yard" and that in turn "hose." "Hose" together with the idea of "cold weather" (an idea not pronounced by S but which came to mind at the time) (record such in parenthesis), called up "freezing" (hose might freeze and be injured). From "freezing" and "hose" came "attic" and "closet" (a good place to put hose). "Closet" started a new train of ideas calling up "roof" (where there had been a leak which was now "repaired." "Roof" and "repaired" called up "gutter" (which needed repairing) and these called up "sand-pile" because the broken gutter caused the rain water to wash the children's sand pile away.

Part 2.—Have S call out 30 words which are unrelated, i. e., have him talk pure nonsense. E should record time again and jot down the words. From S's introspections determine whether S called out all the words that occurred to him. (The time records may help in establishing this point.) Is it possible to think pure nonsense, i. e., to think words utterly unrelated?

Part 3.—Recall (1) the name of your 7th Grade teacher; (2) the names of railroad stations near your home; (3) the authors of text-books used in last year's courses. How did you recall these facts? What ideas intervened between the instructions given here and the proper recall? Note them down. (If S has no difficulty in recalling the items listed in (1) to (3), E should ask for other material which S has some difficulty in recalling. Otherwise the point of this experiment will not be made clear.)

Part 4.—Could you commence playing a piece in the middle where there was no natural break? Can you recite the names of the state capitals without thinking the names of the states? Can you think an idea not led up to by some previous idea?

PLATE X.—Which of these advertisements will cause efficient memory of the product?

Part 5.—Answer the following questions with respect to the four advertisements in Plate X: (*a*) What is the principal idea that is being connected up, (associated with) the product? (*b*) Is this idea a situation leading to the product as a response, or is this idea a response to the product? (*c*) Will this association help you to think of the product at a time when you are likely to be buying the product? In other words, when you are in a position to buy this product is the product going to come to mind and if so, is this particular company's product going to come to mind because of the effect of this advertisement? In answering this question, ask yourself the further question: Just when among all the minutes in a day should this company's product flash into mind?

Part 6.—(*a*) What two factors are essential to efficient reproduction? (*b*) How does this conclusion affect the organization of a lesson, or course of study?

Write up the experiments according to the usual form and hand in at the next class-hour.

LESSON 17

HOW TO REMEMBER (continued)

The Two Factors Essential to Efficient Recall

All habits or memories are composed of a situation, a bond, and a response. These are the three components that were present as the habits were developed and they remain linked together. Psychologically speaking, there cannot be a bond which exists alone separated from its situation and response (we often speak of a bond without mentioning its situation or response, but the latter are always implied as being present). When we speak of a habit or a memory we mean nothing more nor less than that there does exist a bond connecting a certain situation with a certain response. If the response occurs when the situation is encountered, we have remembered. If the response does not occur when the situation is encountered, we have forgotten. We have forgotten because the bond is too weak to function.

These axiomatic statements postulate therefore that *the only way a desired response can be obtained is through the presentation of the situation which is connected with that response.* You can only make a child think "64" by presenting some combination of figures as "8 × 8," which are known by the child to equal "64." Everything that we know, every act we are capable of performing, every thought we are capable of thinking, will remain unperformed or unthought until a situation is presented which will call up these acts or thoughts. No one can think nonsense, utterly pure nonsense, where each item is absolutely foreign to every other item. The "flight of ideas" or "incoherent speech" given in Lesson 1 seems to be pretty near nonsense, pure and simple. But careful study shows that the separate items are connected, though not necessarily connected as rational individuals would connect them.

Reproduction is dependent, then, (1) *on the right situation being presented to cause the desired response and* (2) *on the strength of*

the bond between situation and response. The second factor has already been sufficiently considered and needs to be mentioned here only in order to give us a complete grasp of just how reproduction is to be obtained. If the bond is not strong enough, then even if the proper situation is presented, the response will not follow. This means that if I wish to remember the names of persons to whom I am introduced I must first of all definitely connect up their appearance with their name and, second must practice this connection a number of times. With practice one can learn to note peculiarities in many an introduced person that through the "law of analogy" will readily call up the individual's name. Only a few repetitions are necessary to develop such connections between appearance of the individual and his name. In the cases where no connection between appearance and name appears the bond must be developed through repetition. Having formed a sufficiently strong bond, then, between the appearance of the individual and his name whenever the former is encountered the latter comes to mind.

Until the bond reaches a certain strength it will not function so that the response will occur when the situation is presented. Starting from zero strength of a bond we may have to go to "n" strength before we reach the necessary strength. The term *threshold of recall* has been used to express this idea. Until the bond reaches a certain strength, i. e., rises above the threshold, the response will not be made. This conception of a threshold explains the oft heard expression, "I know, but I can't tell." The individual recognizes the situation, actually knows that he has responded to the situation before, but because the bond connecting the situation and the response is below the threshold, he cannot respond. The expression, when honestly employed, means in the school room that the child has not gone over his lesson sufficiently—that the situation-bond-response elements have been practised but not often, or intensely, enough to insure recall.

Recall and Recognition

Certain distinctions between recall and recognition have been pointed out already in Lesson 2 in discussing the steps of a sight-spelling lesson. Still other distinctions may be considered now.

The writer[1] suggests that recognition is to be explained as follows. On meeting a stranger I react in a certain definite way. The reaction is a very complex affair composed of certain thoughts concerning him, a certain facial expression, etc. Since this total complex reaction has never occurred before it takes longer to respond than it will the second time. (Successive repetitions lower the reaction time and increase the "ease" with which the reaction is made.) Now when I meet this stranger again this total complex reaction is more or less exactly repeated. This time the reaction is made more quickly and with more ease. I am so constituted that I can "note" that the reaction has occurred more easily than if I were reacting to a stranger for the first time. The "noting" is recognition. I don't actually "note" these facts, instead, I simply realize I have met this individual before. Recognition appears, accordingly, when the same response is made, that was made before and the reaction occurs "easier" than if it were an entirely new response. According to this view, "strangeness," "recognition," and "familiarity," constitute mental states which are determined by the "ease" of the reaction.

Upon encountering a situation to which one has previously reacted, he may (1) both recall and recognize, or (2) recall but not recognize, or (3) recognize but not recall, or (4) neither recall nor recognize. When both recall and recognition are present there is complete *reproduction* (memory in the usual sense). The response is again made and we realize we have made it before. "Lucky guesses" in examinations are examples of recall without recognition. The answer is correct but it is not so recognized. Unfortunately, all such guesses are not correct. But the percentage is large enough to warrant such guessing unless it is important that no mistake be made. The third case of recognition without recall is very familiar. We have all had to say apologetically many times, "Yes, I recognize you perfectly, but I can't seem to remember your name." Probably here we make the same general response in terms of facial expression, liking or disliking, noting color of hair, eyes, etc., that we did before and recognize on this basis; but fail to recall the name because the bond between his appearance and name is too weak

[1] M. H. Strong and E. K. Strong, Jr., The Nature of Recognition Memory. *Amer. Jour. of Psychol.*, July, 1916.

to function. In the case when recall and recognition both fail to occur, the bond is too weak for recall or recognition, or a different set of reponses are made. Several men I first met in uniform, I have failed to recognize, probably for this reason.

"Training" the Memory

Much of the work now required of children in school is justified by educators on the basis that it trains their memory. The fallacy in this assumption should be immediately clear to every reader. Substituting the word "habit" for "memory," we would read, Mary learns memory-gems in order to train her habit. Such a statement means nothing, nor does it mean any more when stated, Mary learns memory-gems to train her memory. Memory and Habit are only abstractions. Memories and habits are concrete and numerous. Training Mary to make one response to a certain situation does not aid her directly in making another response to a new situation. Memorization of a poem is one thing, of a Latin conjugation another. And neither helps one to learn chemical formulae nor the various kinds of dress-goods. Each specific habit must be developed by itself. Of course, it is not meant that learning Latin words does not help in learning botanical terms to the extent that there are common elements in the two. But that phase of learning will be discussed in Lesson 49.

Is there any justification, then, for the notion that one gains something from memorizing poetry which will help him in later life?

To make the matter absolutely clear let us at the start again affirm that memorizing one passage does not directly aid in memorizing even another passage. James found that training in memorizing one poem, such as the first book of Milton's *Paradise Lost*, did not improve the ability to memorize other poetry at all.

What then is accomplished by such training? Primarily, various habits of attitude towards one's work are developed, also various ideals concerning work, and various methods of memorizing. In training a child to memorize we are at the same time training him to neglect other things about him and to react to the one thing before him—the passage to be memorized. We

give him a new attitude toward the whole thing—before he may not have realized there was such a thing as a memorized passage. Now he knows there is, and that he can so learn himself. He has likewise learned various methods or devices which are useful in memorizing—e. g., that one must pay attention to the detailed parts of the passage as well as to the general whole of the thing, that one must make an effort to learn—listless repetitions are of little avail, etc. In a general way, then, a student does not improve his sheer capacity to memorize by memorizing but he does improve in a practical way in that he knows how to go to work, that he can learn, etc.

Is not the psychologist making a distinction here which is of no value to the teacher, when he says memorizing does not improve one's capacity to memorize, but nevertheless that through the development of habits and ideals and methods it does make future memorizing easier? Not at all. The distinction is very vital. Instead now of the teacher concentrating her efforts on getting a great deal of memorizing done in order to make her pupils more efficient, she must direct her efforts toward seeing that her pupils do develop proper attitudes toward the work, do memorize correctly. Such a change upon the part of the teacher might result in her cutting down very materially the amount to be learned but in training the children so that they would learn what they did memorize in a far more efficient manner.

How to Memorize

The following eight principles must be borne in mind in memorizing:—

1. Repetition is essential. The longer the period in which the material is to be retained the more the repetitions that are necessary.

2. The first few repetitions will produce noticeable returns; the later repetitions will produce scarcely noticeable returns. These later repetitions are just as important in effectuating a mastery of the material. (Recall data on learning curves.)

3. Reviews at longer and longer intervals are necessary in order to insure that the material will be permanently retained.

4. As soon as possible, cease simply reading through the

material and commence attempting to recall it, prompting oneself when one can no longer recall.

5. Learn by the *whole method* rather than by the *sectional method.* In other words read through and through all the material, rather than memorize one small part at a time. The best method in detail is (*a*) read through the entire passage a number of times to get an idea of it as a whole; (*b*) read through very slowly making sure what each phrase and clause means, so obtaining a detailed grasp of the meaning of the whole selection; (*c*) attempt to recall, prompting oneself just enough to go on. When this stage has been carried to the point that some parts are easily recalled, and other parts are not, then (*d*) take up the difficult parts one at a time and master them. (*e*) Return to the recall and prompting method, going through the entire passage again and again until memorization is complete.

6. *Distributed* learning is superior to *concentrated.* That is, don't attempt to memorize at one sitting, but follow the procedure in (5), doing a little today, a little tomorrow, and so on, until the material is mastered. It is surprising how easily most individuals memorize when they only go over the material once a day.

7. It is not sufficient that one make some reaction to the material to be mastered; one must react to the material with the specific response of recalling just that which is to be retained. An example will make this clearer. Myers[1] gave classes of individuals the impression that they were being tested in speed and accuracy of spelling. He called out six words, one after the other, and after they had been written down, instructed the persons to turn over their paper. They were then called upon to reproduce the list of six words in their proper order. Ordinarily adults would have little trouble in writing out six words just previously heard or written down. But only 5% of 236 college students and school teachers succeeded in making a perfect score when their attention was directed to spelling and not to remembering the six words and in the correct order. Leaving aside the matter of order of the six words, the number of words recalled was as follows:—

[1] G. C. Myers, *A Study in Incidental Memory*, 1913.

6 words were recalled by 25%
5 words were recalled by 41%
4 words were recalled by 28%
3 words were recalled by 5%
2 words were recalled by 1%

The term *incidental memory* has been applied to those cases where we have reacted to a situation in some way or other and then are called upon to make the specific reaction of recalling the situation itself. Another interesting example of this same thing consisted in asking individuals to draw a representation of a watch face, with Roman numbers. Of 200 persons so tested all but 21 put in "IV" instead of the "IIII," and all but 8 put in a "VI." Looking at a watch face thousands of times to tell the time does not equip a person with the ability to recall the details of that watch face.

Because one has made one reaction to a situation does not imply that he will be able to make the specific reaction of recalling the situation itself. To memorize, one must react to the material with the specific reaction of recalling the material; no other reaction is of very much avail.

8. A real aim or motive must be present, else memorization will not occur. That is, without "determination to learn" little will be retained even when the individual complies with (7). For example, one individual has looked up the squares of 13 to 25 hundreds of times and still does not know them. A few repetitions made with the determination to learn them would have been sufficient to insure the proper responses when needed.

Hollingworth[1] reports that a number of individuals were required to call off as fast as they could the names of five colors arranged in an irregular order, twenty times each. This they did 220 times. No one was able to do more than give a few groups of three or four colors in their proper order, and even the proper location of these groups in the series or on the card was impossible. The assistant who had gone over the test about 3,300 times knew scarcely more about the order of the colors than did the subjects themselves.

To secure effective determination to learn requires the presence of some aim or motive. This is, after all, the most important

[1] H. L. Hollingworth, *The Influence of Caffeine on Mental and Motor Efficiency*, 1912, p. 17.

key to memorization. Without a motive the desired results will not occur, not because of an inability, but because of lack of desire.

The writer recalls how stubbornly he refused to memorize "The Lotus Eaters" for an English teacher he disliked on the ground that he couldn't, whereas, at about the same time he memorized "The Shorter Catechism," questions and answers, from cover to cover, in order to earn five dollars. Teachers must present motives for such work. They should go farther than this and so develop boys and girls that they will want to memorize other beautiful passages (or other material), or, at least, read and enjoy such things for their own sakes. (This topic will be discussed in greater detail in Lessons 32 to 43.)

9. One must have the "problem attitude" toward his work (see Lesson 9). One must believe that he can learn. Gilchrist[1] divided a class into two sections of equal ability after the class had gone through a certain assignment. He then addressed the first section as follows: "A hasty examination of the papers of the test just given shows that the members of this group *did not do so well in the test as the average twelve year old child.* I ask you to take the test again." The following "remarks" were addressed to the second section: "A hasty examination of the papers of the test just given shows that the members of this group *did exceptionally well.* I ask you to take the test again." The test was then repeated with the two sections.

The first section actually lost 5% (the scores being 71.75 and 68.38), whereas the second section gained 79% (the scores being 72.42 and 129.50). If a difference of 84% in work done can be secured from college students according as they are told they have done poorly or well, such differences in attitude must be constantly borne in mind by educators. It would be far better to spend the class hour in securing a favorable attitude than to devote it to drill when a class is "out of sorts."

How to Secure Efficient Reproduction

A far more important problem than "how to memorize" is that of "how to secure reproduction" of that which has been

[1] E. P. Gilchrist, Satisfier versus Annoyer. *School and Society,* Dec. 2, 1916, p. 872. (A mistake in the published table accounts for the difference in results given there and here.)

learned. For if an individual cannot utilize what he has learned, it is of little value to him.

We teachers teach facts all right, we form bonds connecting one fact with another in abundance, but we do not so teach that when a need arises in life for these facts there will be recalled to mind what was taught years before. All of us have lamented when it was too late. "If I had only thought of that, and I knew it perfectly well." Knowledge that is not used when needed is mighty near worthless.

We have seen that reproduction will occur when (1) the bond is of sufficient strength to function and (2) the situation to which the response is linked is presented. The "strength of bond" factor must not be overlooked. We shall, however, reserve to Lesson 47 further discussion of this point. What can be done by teachers to provide for efficient reproduction in terms of the second factor?

Examples of Efficient and Non-efficient Reproduction.—To make the second factor clearer, let us consider some cases where individuals did recall and also did not recall, due to the presence, or absence, of the necessary situation.

1. Multiplication combinations are taught correctly in school to secure efficient reproduction. "4 × 9" is presented and the child is called on for the response. The response "36" is needed when "4 × 9" occurs in life. When the bond connecting "4 × 9" and "36" has been sufficiently repeated, the product will be forthcoming whenever the situation is presented.

2. A number of years ago a railroad engineer was examined in court concerning a terrible accident. The accuracy of his testimony depended on whether it was possible for him to have done as many things as he said he did in the exceedingly short time which it was proved had elapsed between his passing a signal and crashing into the other train. In his testimony he stated that for years he had planned what he would do in case of an accident. And at least once a day he had gone through the motions of stopping his train and doing those things needful in an emergency. During those years of railroading he had developed the necessary habits until when the emergency came he did what there was for him to do in an exceedingly short time. This is the way to train oneself to meet emergencies.

The only way to secure efficient reproduction (proper action)

is to do those acts themselves as responses to the situations which may arise. From principal to kindergartener the only way to prepare to react to a sudden fire is by going through the fire drill until it has become second nature. It does little good to read about how to save a person from drowning. The situation which will confront one will be an apparently lifeless body, not a book, and the responses that are needful are certain movements of the hands and body, not a lecture on the subject. To be prepared is to have gone through the performance using a friend in the place of the lifeless body.

3. The writer was told one day by a friend who was interested in High School physics that he did not believe 10% of a certain group of college students could repair their own door bell when it was out of order. Yet all of them had had a course in physics in High School including the subject of electric batteries and door bells. Very likely many of them could respond to the situation "Examination question, 'Draw a diagram showing how you would connect up an electric bell'" by drawing the desired diagram. But apparently this situation is so different from the actual situation of finding a door bell in the kitchen, the batteries in the cellar, and the push-button beside the front door, that knowing the response to the first does not help in responding to the second. Of course, the responses are very different. One involves using a pencil and paper, the other a step-ladder, screw driver and knife. Training the hand to draw is not training the hand to turn a screw driver, etc. Undoubtedly, before we shall make our physics course as practical as it should be, we shall have to introduce real situations into its teaching. If an electric bell circuit was set up in the laboratory and then put out of order and the students were called on to fix it as one of the regular assignments there would not be a great number of physics graduates who could not apply their science to this life problem.

4. Consider two advertisements that might have been included in Plate X. One depicts a man seated at a dining room table eating breakfast all alone, with a bottle of milk and a package of Kellogg's Corn Flakes prominently displayed. The heading beneath is "My wife's gone to the country." The other advertisement reproduces the statue of Venus de Milo, which occupies most of the page. The words "Kellogg's Corn Flakes" are also conspicuously present. This second advertisement will not

secure effective memory because it associates corn flakes with Venus de Milo. Such a thought does not make one want to eat corn flakes and when, on the other hand, one thinks of this famous statue, one is not in the mood or place to buy breakfast food. But the first advertisement is planned so as to develop effective memory. A husband, eating a solitary breakfast, is likely to have this scene flash into mind suggesting to him the desirability of this sort of breakfast which he can so easily get for himself. Or the wife, planning for her husband's breakfasts in her absence may have this scene come to mind and so think of corn flakes. In the case of either husband or wife a situation is presented to them which they are likely to encounter in life and the situation thus calls to mind the product.

5. Let us consider a far more general type of behavior, where it is clearly impossible to connect all the situations a boy or girl will meet in life with the proper responses. In such cases a *general conception* has to be developed. A respect for property rights can be grounded on the conception that practically everything belongs to someone. This is established by leading the child to see the truth of it in many particular cases. The conception can further be strengthened by giving him things of his own and respecting his ownership of them. Such a child on encountering the situation, "Money on counter. No one present," will not react to just those two details, but to these plus the third one of, "All objects belong to some one." The richer this detail is in meaning, *i.e.*, the more strongly it is bound to the idea of leaving things alone, the more likely it is that the response to the money will be a reaction to the third detail and not to the first two. The third detail is of course supplied by the boy himself but it is called up by the first two due to careful training. The more abstract the training concerning honesty, the less likely is it that the details. "Money on counter. No one present," will call it to mind. The more concrete the training, the more it has had to do with actual examples, the more likely that the concrete money will recall the training. Most abstractions are far removed from the little affairs of life. Honorable conduct must be developed through supplying the individual with proper responses to the situations which will actually confront him.

Efficient Development of General Habits, or General Conceptions.—The habit of saying "36" upon seeing "4 × 9" is

specific; the behavior of leaving other people's things alone is general. When "courtesy," or "tact," or "courage" are used, we have in mind many habits, some of which are specific, like taking off one's hat to the ladies, but most are general, like saying inconsequential things that make people feel at home. Much of what is meant by "culture" is covered by general habits. These need to be developed in school as much as more specific ones.

Far more stress must be placed upon the determination of what general conceptions are to be taught than has been done. Take the case of History of Education. Is this course required of prospective teachers in order to acquaint them with the history

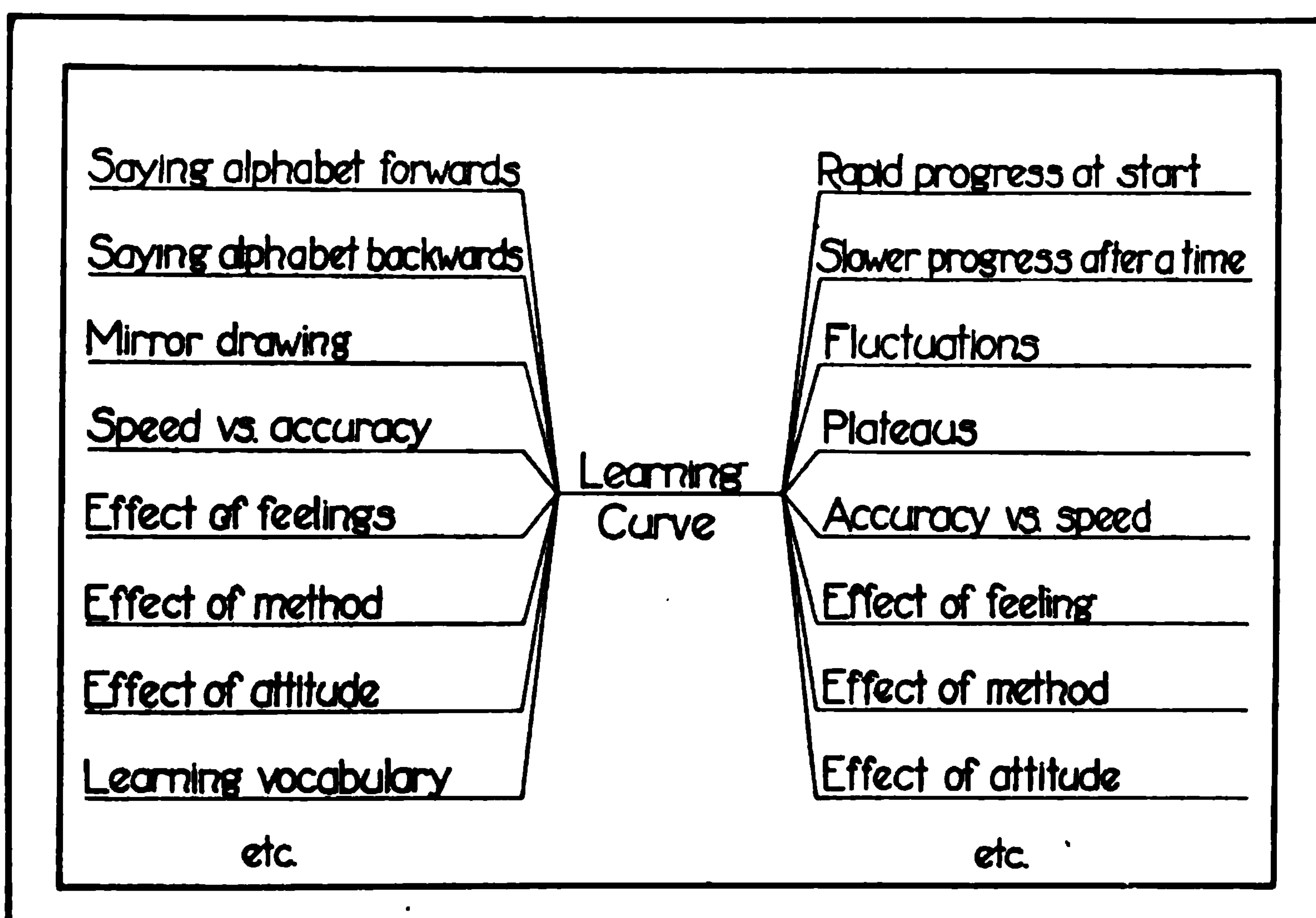


PLATE XI.—Illustrating the functioning of a "central conception."

of educational movements or is it required in order to fit them to teach more efficiently? The usual text-book answers that the former is the aim of the course. Consequently the details of the course are built around such topics as, Greek Education, The Renaissance, Realistic Education, and the like. How many graduates of such courses ever use what they learned? But if the other aim was before the text-book writer, specific problems of modern education would appear as chapter headings followed by a presentation of the experiences of the past bearing on the

problem. The graduate of such a course could hardly help using the material in such a course because every time one of the problems discussed in the text was encountered, what had been studied would flash into mind. As it is, one does not meet "Renaissance" or "Realistic Education" in his daily work and so does not have the ideas linked to them come into mind.

Consider in this connection the organization of this text-book. Over and over again you have performed experiments and plotted learning curves. From these curves you have learned many facts about the learning process, e. g., rapid progress at the start, slower progress after a time, fluctuations, that the shape of the curve tells interesting facts about the learner's previous training and about his natural ability, relation of progress to changes in method, to feeling, etc., etc. You can never again see a learning curve and not think many of these facts for they are connected with the curve. Moreover, when you see a particular curve you will think of those principles and facts which that curve suggests. In other words you have learned to understand a curve. In terms of the diagram (Plate XI) bonds have been formed between "learning curve," the *central conception*, and all the items to the right.

But all of this is not enough, although it is just where most instruction stops. It is necessary that you be so taught that it will not be left to accident that this central conception (learning curve) will occur to you. For it is the key which will unlock all your knowledge on this subject. If it is not present you will probably not recall the remainder of the material. How can it be arranged that you will think "learning curve" when confronted by certain problems in teaching? It can be accomplished by associating many such problems with "learning curve." You have already made such associations in the lesson on vocabulary study and on teaching the violin.

In terms of the diagram (Plate XI) bonds have been formed between a variety of teaching situations and the central conception, "learning curve."

The writer has so organized the material in this course (1) that many concrete cases in school room procedure have been associated with the learning curve and (2) that the learning curve has been associated with a great deal of the material in the course. It is impossible to connect up each detail in life with the proper

details in this course. But you can be trained to think "learning curve" when confronted with a school problem and then go from the intermediate step (learning curve) to almost anything in this course. When Mary Ann does poor work you will now respond to "Mary Ann and her poor work" plus "learning curve," and then you will recall "plateaus," "attitudes," "changes in method," etc. Your analysis of her trouble in terms of all these detailed considerations will enable you to decide very much more wisely just what to do with her.

Put things together in school that need to go together in daily life and put them together in the same way that they will occur in life. If the material is complex, as in this course, then select *one or more central conceptions and connect up situations the child will meet in life with this central conception* and *also connect up the central conception with the facts and principles in the course.* In this way will you provide for efficient reproduction.

LESSON 18

SUMMARY OF LESSONS 1 TO 17

Components of Behavior

Behavior can be broken up into the three components of *Situation*, *Bond*, and *Response*.

Some Bonds are Unlearned, Others are Learned

All acts of behavior involve a response to a situation. And this condition postulates the existence of a bond between situation and response. It is evident from the experiments which have been performed that bonds are formed—that at one time in a person's life certain bonds did not exist which later came into existence. Such changes are what is meant by learning—the development of new bonds. A still closer study of man's behavior, especially when he is an infant, leads us to realize that there are some bonds which do not develop through the process of learning. Such bonds develop naturally: just as naturally as do man's teeth, hair, blood vessels, or digestive system. Situation-bond-response combinations which develop naturally are referred to as *reflexes* or *instincts*. Combinations, on the other hand, which are acquired through learning are termed *habits*. (To be discussed further in Lessons 31 to 37.)

Reflexes and Instincts.—A reflex is an act in which there is a simple stimulus as the cause of the excitation followed by a simple response, the bond or connection between sense-organ and muscle being unlearned. Reflex acts are such as jerking the hand away from a hot stove, winking when an object suddenly comes toward us, coughing when the throat is irritated, etc. An instinctive act, on the other hand, is one in which there is a more complex situation, ordinarily, followed by a more complex response, the bond being also unlearned. Instincts would be illustrated by such behavior as a mother's reaction to her baby's cry, fear and flight from a large animal, a boy's interest in girls, etc.

The most important point to note in all these cases is that the response is always one that is made naturally without any training. In other words, the *bond* connecting situation and response is *unlearned.* This means that nervous connections are already formed between sense-organs and muscles, so that when man is confronted with certain situations he responds automatically, immediately and without conscious guidance.

There can be no sharp line of demarcation drawn between reflexes and instincts any more than there can be a sharp division of all men into the two groups of short and tall men. Some men are undoubtedly short or tall, just as some unlearned performances are clearly reflexes or instincts. But most men are neither decidedly short nor tall. In the same way most unlearned performances can be classified either as reflexes or instincts depending upon the definitions set up. In a general way, reflexes are simple acts, involving little or no consciousness of what is being done and seemingly carried on by only a part of oneself, as the hand, eye, etc. Instincts are more complex, consciousness is involved, and I feel that I myself am involved, as when I pet a baby, or run from a bull, or get interested in a girl.

Habits.—On the other hand, habits are situation-bond-response combinations which have been developed through training. At one time there was no bond. Unless such new bonds were formed man would not advance beyond the limits of his reflexive and instinctive equipment.

Learning and Forgetting

Learning consists in the formation of bonds between situations and responses and the strengthening of the bonds so that they function more efficiently. *Forgetting* is the opposite of learning; it is the effect of bonds becoming weaker and weaker until they no longer function. A somewhat similar effect is produced through *interference.* Freud claims that forgetting is also due to the fact that we want to forget, because the memory is unpleasant. It is for this cause, he says, that we forget a troublesome engagement. This type of forgetting may possibly be explained as due to interference. Take the case of the boy who is told that when he comes home he is to chop wood. There is here

interference between spending the afternoon chopping wood and playing football. The latter is the stronger response due to habit and interest, and so "interferes" with the other response. Most failures to chop wood are sheer disobedience, but sometimes Freud is correct in saying that the duty is actually forgotten.

The Laws of Learning

The laws of learning are the laws as to the formation, strengthening, and reorganizing, of bonds. For example: There is rapid movement at first with less and less improvement as practice continues; improvement is never continuous—there are always fluctuations in the curve of learning; under certain conditions plateaus develop—periods of no apparent improvement; and there is a limit to improvement (physiological limit) beyond which we cannot go, but which is practically never reached, due to lack of sufficiently strenuous practice.

Learning may be considered in terms of: (1) The formation of new bonds, (2) the reorganization of situation-bond-response combinations, and (3) the strengthening of bonds.

Formation of New Bonds

A new bond is formed through trial and error or stimulus substitution.

Trial and error learning occurs when the response that is desired (1) is not connected to any stimulus at all, (2) is not connected to any element in the situation, or at least to any potent element in the situation and (3) is a complex response and the proper sequence or coordination of movements is not known.

There are very few examples of the first case where there is no stimulus connected with the desired response. Learning to wag one's ears is, however, one example. Here there actually exist motor nerves running to the muscles that move the ears but there is no stimulus that will set off the movement. As the movement has never been made, one does not know what it is. And it is difficult to ascertain from watching our own performance in a mirror when we have really made the movement we have seen another make. For sometimes we move our ears but also our whole scalp, or the side of our face. The latter element we do

not want. To acquire this stunt means that we must just keep trying and trying. Because of the phenomenon of overflow of energy (Lesson 9), eventually this little-used pathway to the ear muscles becomes well used and under conscious control.

The tri-trix puzzle, (see Plate XII), illustrates the second case, where the desired response is not set off by the situation. One accordingly makes all manner of random movements in the endeavor to get the four shots into the four outer holes, and usually does not succeed. But if one gets in some way or other the idea of whirling the puzzle, it is solved. The random move-

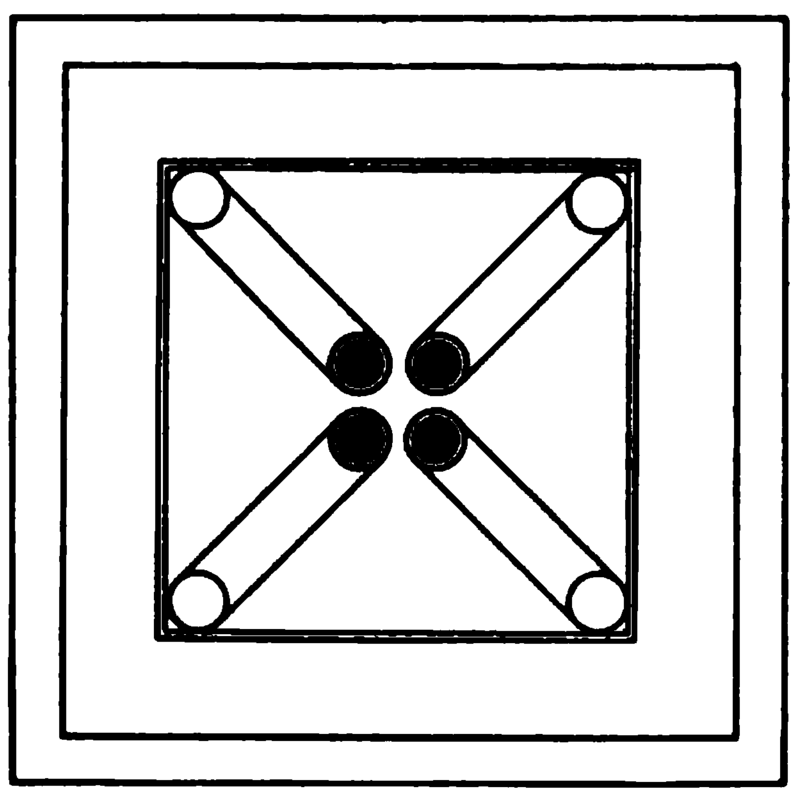


PLATE XII.—The tri-trix puzzle. It is solved when all four shot are rolled into the four outer holes.

ments occur because no element in the situation sets off this necessary response of spinning. One of the important functions of teaching is to eliminate useless trial-and-error learning by so manipulating the situation as to have before the learner those elements which lead him to act as desired. The student of this text, for example, has learned a great deal from the experiments that he has had to perform and he has learned it with a minimum of trial and error.

In the third case the learner may have at his disposal all the habits necessary to perform the act but because he does not know the proper sequence or coördination of the several habits he is forced to resort to trial-and-error learning. This is true in all cases of acquiring skill, whether of handwriting, skating, driving an automobile, using tools, or what not. A simple example may

be found in the mirror-drawing experiment. Take the one movement of tracing a line that appears in the mirror to go away from the body, diagonally to the right. And, to make the case still simpler, suppose that the learner knows that he must draw toward his body when the direction appears to be away from the body and that he must draw to the right when the direction appears to the right. Even then he will have to try and try before he will develop just the proper coördination of movements that are necessary to make the compound movement. But his random movements will be very slight as compared with one who does not understand the two components that make up his task. Here again it is the function of the teacher to eliminate as much trial and error learning as possible by leading the student to analyze his problem into its elements and work out the response to the elements one at a time. But no teacher can entirely eliminate random movements, for coördination comes only that way.

Stimulus Substitution.—New bonds can also be formed through stimulus substitution. In such cases there are present simultaneously, or in immediate succession, two stimuli followed by their responses. Repetition results in a bond being formed between S_1 and R_2, also between S_2 and R_1. Which of these two new bonds is primarily developed depends upon the set or attitude of the learner. (Refer to Lesson 11 for further discussion.)

Reorganization of Bonds

Here we are concerned primarily, not with the formation of new bonds, but in their rearrangement into new combinations. Most learning in school belongs here, particularly in the upper grades. From the standpoint of the results, three types of reorganization may be distinguished: i. e., (1) linking elements together through the use of old bonds (associative shifting), (2) short-circuiting, and (3) integration.

Associative shifting has been discussed in Lesson 11. Another example besides hund-hound-dog is the learning of an automobile license number, as, for example, 149,002 by associating it with the date Columbus discovered America with two (the same number as the last one in the license number) zeros before the

2. The whole process of thinking is largely a manipulating of associations that come to mind one after the other.

Short-circuiting can be illustrated in the case of saying the alphabet backwards. One individual's associations in response to the instructions to recite the alphabet backwards were: "last letter in alphabet"—"z"—"next to last letter"—"y"—"letter before y"—"xyz"—"letter before x"—"rstuvwx"—"w"—"rstuvw"—"v"—"rstuv"—"v," etc. As repetition after repetition continued the unnecessary steps were eliminated, or short-circuited, until finally the alphabet was recited backwards without a break. The above steps came to mind through associative shifting—through utilizing already existing bonds. The short-circuiting can be partly explained in terms of stimulus substitution as follows:—

Situation		Response
w	⟶	rstuvw
rstuvw	⟶	v
v	⟶	rstuv
rstuv	⟶	u

The repetition of almost any performance results in short-circuiting the unnecessary steps. And most of the improvement takes place without any consciousness of the changes. These changes are all the more likely to occur if we are attempting to improve the quality of the work or to cut down the time of doing it. If we are making no such effort, a minimum of short-circuiting results.

Integrations.—This topic is discussed later in Lesson 45. A simple illustration of what is meant by the term is sufficient at this point. A child develops certain responses to the sight of an apple, to the feel of it in his hands, to the smell of it, to the taste of it, and to the sound of eating it. As all these various stimuli and their responses occur together, the child develops many fusions of them whereby, if he sees, for example, the apple, he may react as though he had not only seen it, but had felt it, smelt it, tasted it, or had heard someone crunching it. One stimulus arouses in this way a complex response. The reader's response to "learning curve" is now a response that is an integration of many separate responses which have been more or less welded into one complete conception of the subject.

The Strengthening of Bonds

Bonds are strengthened by repetition, intensity, and the effect of satisfaction. They are weakened by lapse of time, interference, and the effect of dissatisfaction.

Efficient Memory

Efficient memory is dependent upon bonds sufficiently strong to function and the connecting up of what is to be remembered with situations that will occur when the response is desired.

What the Learning Process Means to Education

Evidently, *learning is connecting.* It is the forming of a bond between a situation and a response; the development of a habit. Clearly also, early in life the new connections will be slight modifications of reflex and instinctive actions; later the new connections may join great groups of complex habits together into such complicated processes as playing the piano or solving an original in geometry.

Teaching is, then, *the manipulation of the details making up the situations which confront children so that as they respond they will constantly form new habits and, moreover, habits that are desirable ones.* If the desired responses are new ones for the child then the learning must be of the "trial-and-error" type. But if the desired reponse is one that is already a response to another situation the new situation and old response can be connected together through associative shifting. For example, take the case of a boy learning to climb over a wooden fence. If he goes at it alone it will be largely a matter of "trial-and-error," because he will not analyze the entire performance into parts each of which he is already capable of doing. But if one who understands the movements to be made stands by and calls out "Now climb the ladder" he will make the movements previously associated with climbing a ladder. "Now put one leg over the top," he will respond by throwing one leg over the top board, as he has often done in climbing out of his crib. "Now cross your hands," "Now put the other leg over," "Now face me," "Now climb down," he will climb over the fence in a fairly smooth

and efficient way the first time. He does so because he has utilized old responses, one at a time, and he has utilized them because the old situations connected with them have been presented by the parent in the proper sequence. A little practice, then, results in connecting all of these responses together in a string just as the responses in saying each letter of the alphabet are connected together.

In what has gone before we have obtained a general conception of the learning process and of the mechanism by which situations become linked up with responses. In the lessons to follow we shall take up the matter of learning in greater detail. But the whole subject centers about this main theme just expressed, that the child's learning is conditioned by the skill the teacher displays in presenting situations to him. Lessons are difficult or easy depending not on the material of the lesson, ordinarily, but upon the order of presentation of the details in the lesson—an order depending upon what habits the child has already acquired.

Learning the characteristics of the learning process, as you are doing in this course, can be made by any particular author to fit any one of the types of learning. He can supply you with every detail in one, two, three order and expect you to memorize the material and through drill have you recite it as glibly as you do the alphabet. Or he can assign very indefinite problems and leave you to discover the elements and their order of relationship. The former, however, will not result in your obtaining a workable use of the material: the latter will take too long and is too discouraging, although if you do learn this way you have a wonderful grasp of the subject. Consequently, the present author prefers to introduce each topic by way of an experiment whereby you will have to work out the answers yourself. Then to follow the experiment with a discussion so that missing material may be identified and learned and the relationship of the various parts fully comprehended.

LESSON 19

MEASURING DIFFERENCES OF PERFORMANCE AMONG INDIVIDUALS—THE AVERAGE DEVIATION

The general characteristics of learning have now been presented. Differences between individuals have so far been ignored in our eagerness to discover the common principles found true of all individuals.

It is important to stop now and resurvey some of our material to see to what extent individuals are alike and to what extent they are different, and in what the differences consist.

In order to make these studies effectively it is necessary to become familiar with three mathematical conceptions, known as the "average deviation" (discussed in this lesson), the "normal curve of distribution" (Lesson 24), and the "coefficient of correlation" (Lesson 28).

All of these conceptions are basic to modern psychology, as well as to biology, sociology, economics, education, etc., and are worth understanding for their own sake, as well as for their use as tools in applying scientific principles to everyday problems.

THE AVERAGE DEVIATION

Two fourth grade classes (A and B) were given the same test. The scores of the forty students were as follows:

Class A		Class B	
Pupils	Grades	Pupils	Grades
1	96	21	87
2	88	22	80
3	80	23	74
4	80	24	73
5	68	25	64
6	68	26	63
7	60	27	58
8	60	28	57
9	56	29	56
10	56	30	55
11	52	31	53
12	52	32	52
13	44	33	46
14	40	34	43
15	36	35	41
16	36	36	40
17	24	37	32
18	24	38	31
19	24	39	30
20	16	40	25
Total..........	1060		1060
Average........	53		53

When we average the twenty grades in each class we find the averages are the same, i. e., 53. But when we look over the scores we discover immediately that the two classes are not equal in performance. Class A has two students superior to any in Class B and four students inferior to the poorest in Class B. As far as this particular test is concerned it shows that the students in Class A are more unlike among themselves than are the students in Class B. In other words, there are greater differences in ability in Class A than Class B.

Such differences in ability in classes form an important consideration in the administration of a school. For the more homogeneous a class, the easier it is to handle. One of the duties of a principal is to assign pupils so as to have the smallest differences possible in a class. We shall come to appreciate this point more fully in the next few lessons.

It is clear that to state that Classes A and B have the same average is not sufficient. The total grades tell us another important point. But it is extremely awkward to have to reproduce in a report all of the grades of the pupils. Is there not some short-cut method by which these individual differences can be expressed?

It is just this that the "average deviation" gives us. It is a measurement used as a supplement to the average in studying individual differences. This measurement means exactly what the two words imply—the average amount of difference of the individuals making up the group from the average of the group as a whole. Consider carefully how it is obtained in the following examples (Table II). First, the average of the figures themselves is obtained. Second, the difference between the average and each separate figure is obtained. Third, the average of these differences or deviations is obtained. This is the average deviation (A. D.).

Knowing the average for each class and the average deviations, i. e.,

Class A—Average 53, A. D. 18.2
Class B—Average 53, A. D. 13.7

we can readily determine, if we do not have the original data, that there was a very great variation in the individuals. But of the two classes Class B is more homogeneous. We know now for certain that the average does not represent what all twenty pupils did. Far from it. Some must have varied above and below 53 by more than 18.2 (or in Class B more than 13.7) in order that the average of all the deviations should be 18.2.

It is mathematically true that very few cases will ever differ from the average by more than three times the A. D. For example, it is unlikely we would have pupils in Class A with grades higher than $53 + (3 \times 18.2)$ or 107.6, or lower than $53 - (3 \times 18.2)$ or -1.6; and in Class B higher than $53 + (3 \times 13.7)$ or 94.1, or lower than $53 - (3 \times 13.7)$, or 11.9. In these particular classes we do not have any cases varying as much as these limits.

TABLE II.—ILLUSTRATING THE METHOD OF OBTAINING THE AVERAGE DEVIATION (A. D.)

The left hand of the table illustrates the work, involved in obtaining the A. D. of the grades of the 20 pupils in Class A, while the right half of the table shows similarly the work involved in obtaining the A. D. grades in Class B.

Class A			Class B		
Pupils	Scores	Differences	Pupils	Scores	Differences
1	96	96 − 53 = 43	21	87	87 − 53 = 34
2	88	88 − 53 = 35	22	80	80 − 53 = 27
3	80	80 − 53 = 27	23	74	74 − 53 = 21
4	80	80 − 53 = 27	24	73	73 − 53 = 20
5	68	68 − 53 = 15	25	64	64 − 53 = 11
6	68	68 − 53 = 15	26	63	63 − 53 = 10
7	60	60 − 53 = 7	27	58	58 − 53 = 5
8	60	60 − 53 = 7	28	57	57 − 53 = 4
9	56	56 − 53 = 3	29	56	56 − 53 = 3
10	56	56 − 53 = 3	30	55	55 − 53 = 2
11	52	53 − 52 = 1	31	53	53 − 53 = 0
12	52	53 − 52 = 1	32	52	53 − 52 = 1
13	44	53 − 44 = 9	33	46	53 − 46 = 7
14	40	53 − 40 = 13	34	43	53 − 43 = 10
15	36	53 − 36 = 17	35	41	53 − 41 = 12
16	36	53 − 36 = 17	36	40	53 − 40 = 13
17	24	53 − 24 = 29	37	32	53 − 32 = 21
18	24	53 − 24 = 29	38	31	53 − 31 = 22
19	24	53 − 24 = 29	39	30	53 − 30 = 23
20	16	53 − 16 = 37	40	25	53 − 25 = 28
Total...	1060	364		1060	274
Av......	53	18.2		53	13.7
The A. D. is 18.2—the average of the differences (deviations).			The A. D. is 13.7—the average of the differences (deviations).		

PROBLEMS

Find the A. D. of the grades in the following classes:

1. Class C is composed of pupils 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19 in Class A given above.
2. Class D is composed of pupils 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20.
3. Class E is composed of pupils 1 to 5, and 16 to 20.
4. Class F is composed of pupils 6 to 15, inclusive.

Check your answers with the instructor at the next class-hour. If incorrect spend part of that hour making sure you understand how to get an A. D.

NOTE.—Bring coördinate paper with you to the next class-hour.

LESSON 20

HOW DO INDIVIDUALS DIFFER IN LEARNING MIRROR-DRAWING?

We have so far studied a number of learning curves. We have discovered some general facts about the process of learning—about the process of learning taken on the average. But it is worth while to stop and consider whether all individuals learn in the same way.

We know that people differ. We know that they differ in the way they do a certain lesson, that they differ in the time it takes them to learn the lesson, in the way they answer questions about the lesson, etc. We know some get good marks and some get poor marks. Why are there all these differences? What are the causes of individual differences?

Let us consider just one of these problems. Let us study the data from 10 individuals in the mirror-drawing experiment and see in what respects they are alike and in what respects they are different.

Below are given the results of ten individuals (called A to J) in the mirror-drawing experiment. The records are a combination of their time and error data. Endeavor to discover by yourself, together with the help of your partner, as many ways as you can in which these records are (1) alike and (2) different. That is, exactly what are the characteristics which are common to the learning of these ten individuals and, on the other hand, in what respects do the records of their learning differ?

The Use of Tables of Statistics versus Curves.—When confronted with many figures as in Table III, one should endeavor by some means or other to present them in a diagram or set of curves. No one can grasp the significance of a complex set of figures from studying the figures themselves with anywhere near the ease that he can from seeing those same figures set forth in curves. In general, curves should be used for discovering or for presenting general relationships, while tables should be used when the facts need to be ascertained very accurately.

TABLE III.—RECORDS OF TEN DIFFERENT INDIVIDUALS (A—J) IN MIRROR-DRAWING EXPERIMENT[1]

Trials	A	B	C	D	E	F	G	H	I	J	Average
1	232	76	210	363	216	286	283	701	129	131	263
2	193	77	152	167	147	144	148	184	94	90	140
3	157	80	115	128	160	109	69	148	98	75	114
4	115	68	108	143	113	141	66	144	91	67	106
5	133	70	108	132	110	97	76	98	84	75	98
6	88	57	115	125	103	99	59	90	69	64	87
7	87	65	96	121	90	97	50	87	67	67	83
8	90	62	92	149	91	111	53	81	75	51	86
9	102	65	62	140	92	101	48	79	70	49	81
10	88	54	71	121	75	89	56	72	55	49	73
11	102	59	68	121	90	115	56	71	66	51	80
12	88	63	59	112	74	87	51	58	57	55	70
13	87	51	56	95	64	90	50	63	55	47	66
14	79	57	58	95	70	87	44	56	59	46	65
15	89	53	60	86	75	81	43	55	59	38	64
16	64	48	55	114	59	84	38	54	51	44	61
17	68	46	61	100	62	81	36	54	59	43	61
18	71	37	53	116	59	71	43	62	54	30	60
19	55	49	42	122	51	69	40	53	52	31	56
20	61	50	58	85	52	70	35	60	40	36	55

THE ASSIGNMENT

First of all, then, plot the ten sets of figures. Two or three curves can be drawn on the same sheet of paper.

Now from a study of your curves and your table ascertain whether all ten agree or disagree on the following points:

1. Do they show improvement with practice?
2. Do they show the same initial efficiency?
3. Do they show the same final efficiency?

[1] The data presented here were actually obtained from ten individuals. The individuals have been so selected, however, that the conclusions obtained from these data will agree very closely with similar calculations based on a study of 56 individuals. The averages obtained from 56 men and women are respectively:—242, 159, 137, 120, 114, 99, 94, 86, 88, 83 79, 76, 74, 74, 70, 70, 68, 64, 64, 63.

Each figure represents the time consumed in doing the drawing plus the, number of errors that were made in that drawing.

4. Is a greater gain made during the first five trials than during the last five?
5. Is progress regular or irregular?
6. Do all curves show an equal gain?

Back up each of your assertions with proof from your data.

Second, if we should arrange the ten individuals according to their initial ability in this performance we would have them in this order: B(76), I(129), J(131), C(210), E(216), A(232), G(283), F(286), D(363), and H(701). Copy this order onto a sheet of paper so that the letters will appear in a column one under the other. Now arrange the ten individuals according to their final ability in this performance in a similar column. Study the relationship between the two columns of letters and then decide whether individuals who are best at the start are best at the end or not. Does your conclusion hold good for all ten or for only the majority? If you have exceptions to your rule, can you explain why there should be these exceptions? Make a further comparison (a) between the order of proficiency at the start and the order at the tenth trial, and (b) between the order at the tenth trial and the order at the last trial.

Do you think that B, who is best at the start and fourth at the end, and I, who was second at the start and third at the end, will do better, equal to, or poorer than D and H in arithmetic, geography, running a grocery store, or driving a plow? Explain. What significance, if any, do you think there is in the superiority of B and I over D and H in this performance? How would G compare in these respects with the four (i. e., B, I, D and H)?

Hand in your report at the next class-hour, written up in the usual manner.

LESSON 21

INTRODUCTION TO THE GENERAL SUBJECT OF INDIVIDUAL DIFFERENCES

Individuals differ very materially with respect to every human trait. If we compare them with respect to height, or weight, or muscular strength, or lung capacity, or eyesight, or hearing, or color of hair, or spelling ability, or musical ability, or inventive power, or any other trait, we find that they all differ from one another in these respects. When one is at first confronted with all these differences one is very apt to become utterly confused and feel that there is no order at all in this chaos of human differences. The person who is the tallest is not always the heaviest. In fact, he may be very thin and weigh comparatively little. The person who has the best eyesight may have any color of hair and may have very good or very poor hearing. The musician may also be a poet or he may be unable to express himself very clearly in any way except on his musical instrument.

Still as we progress in our study of these differences we come to see that all is not chaos, that there is some system underlying the matter. As yet science has worked out but few of the great laws involved. But a start has been made, and already we have been helped in understanding the peculiarities of our friends and pupils.

There is no more important subject for the teacher in psychology than this subject of individual differences. If we were all alike then teaching would be a comparatively easy subject. We would need to know just the physical, mental, and moral dimensions and requirements of the standard and then devise one set of methods which would fit in every case and inevitably produce good spellers, writers, etc. But people are not alike. And this fact means that no one method will work with every individual. Methods of teaching when applied to certain

children will produce the desired result and when applied to other children will produce no result worth while or possibly just the opposite result from that desired. Undoubtedly some of the children who fail in the 4th Grade fail because the wrong methods were applied to them. If other methods had been applied some of these failures would have succeeded but, on the other hand, some of those who succeeded would then have failed. What is needed today is that teachers become expert in understanding the differences in children and so be able to apply intelligently varying methods to varying needs. Without doubt the teacher of the future is going to become a diagnostician in much the same way that a physician is. The latter studies symptoms, diagnoses the diseases, prescribes the treatment, and if he is fortunate directs that treatment until the patient is cured. The teacher of the future will be one who will understand the peculiarities of children and on the basis of these peculiarities or differences diagnose the reason as to why the child is not developing properly, prescribe the treatment, and carry it out to a successful end. This is exactly what is now being attempted in our special classes for the defective. And although possibly it is easier to do this with defectives than with normal children, yet society cannot permit the poorest and most worthless one-tenth of our children to have a better type of teaching than that given to the remainder, who will have to carry not only their own burdens, but also a large share of the burdens of the defective class.

Now let us turn and consider such facts and principles as we can discover concerning individual differences.

Individual Differences, Based on Mirror-drawing Experiment

It is clear from a study of the learning curves of the ten individuals recorded in Lesson 20 that they all agree in that:—

1. They show improvement with practice.

2. They make greater gain at the start than at the end of the practice.

3. They progress irregularly, i. e., they do not always advance but sometimes do more poorly than in the preceding trial. We shall find after studying many examples of learning that these

three facts remain true. Even though individuals differ tremendously, yet they do not differ as regards these respects. *Continued practice does produce improvement in a performance in the long run, but it may not be apparent when two or three or even more successive trials are alone compared. Improvement is also greater at the start of practice than at the end.*

On the other hand, individuals differ as regards:—

1. Initial efficiency.
2. Final efficiency.
3. Amount of improvement.

This is clear from the data in Table III. It will be found to be true when any set of data is studied.

The Use of the Average as a Measure of a Group

We can obtain an *average* from the records of a large or small number of individuals. Such an average record is given in the last column of Table III. When we study this average record from ten individuals we realize that it is an expression of the entire ten records. But it is not typical of what any one person would do. No one of the ten did the mirror-drawing in 263 units (of time and accuracy combined). The nearest to this record was G, who did the experiment in 283 units, differing thereby from the average by 20 units. On the other hand, B (the best of the ten) beat this average by 187 units, and H (the poorest of the ten) was poorer than the average by 438 units. Clearly a great many interesting facts are covered up or lost by referring to the average as an expression of what this group of ten individuals could do. By knowing only that the group averaged 263 units for its first trial we would have no knowledge of how much the ten had differed or varied from each other.

We have come also to realize that any individual learning curve is not perfectly smooth but has a great variety of fluctuations in it. In other words, although a person may be progressing, his successive performances may not necessarily show this. Sometimes he gains, sometimes he loses, but on the whole he is advancing. Now our average record of the ten individuals in the mirror-drawing experiment is singularly free from such fluctuations. Only twice does the curve rise (show decrease in efficiency) and then only for slight amounts. From a study of

the average curve we would be led to the false notion that improvement is very steady and even. But such, we realize, is not the case. Evidently, then, the average, although very useful, is not a sufficient measure of a class performance to tell us all that we need to know about that class.

Consider another example taken from a survey of the Demonstration School of George Peabody College for Teachers.[1]

All of the children in Grades IV to VIII were tested with the *Kansas Silent Reading Test.* This test consists of a number of paragraphs like the following:—

No. 1

VALUE 1.0 The air near the ceiling of a room is warm, while that on the floor is cold. Two boys are in the room, James on the floor and Harry on a box eight feet high. Which boy has the warmer place?

....

No. 2

VALUE 1.3 If gray is darker than white and black is darker than gray, what color of those named in this sentence is lighter than gray?

....

No. 3

VALUE 1.6 We can see through glass, so we call it transparent. We cannot see through iron, so we call it opaque. Is black ink opaque, or is it transparent?

....

The children are allowed five minutes in which to read over as many of these paragraphs as they can and to execute the directions in each. They are scored in terms of the paragraphs to which they have correctly reacted, each paragraph counting proportionately to its determined difficulty or value.

In Table IV are presented the average scores of the five grades, together with the *norms* for those grades. A norm is a standard set for a grade after testing thousands of children so as to know exactly what the average is. From these figures it is clear that with respect to this method of testing silent reading the children in the five grades are superior to children throughout the country

[1] C. C. Denny. *The Peabody Demonstration School in the Light of Standard Tests.* Unpublished thesis in the library of George Peabody College for Teachers.

as in all the grades except VII the average of the grade is superior to the norm and in Grade VII the figures are equal to the norm.

TABLE IV.—AVERAGE SCORES AND NORMS, GRADES IV TO VIII

Kansas Silent Reading Scale

GRADES	IV	V	VI	VII	VIII
Averages....................	13.0	15.7	16.8	16.5	23.4
Norms......................	9.4	13.4	13.8	16.5	19.2

As has been said the averages "show the school to be in most excellent condition." However, if this is all that the class-room teacher is to learn from the test, the very knowledge that should enable her to give her pupils, as individuals, the best possible instruction will have been missed. The scores, in rank order, of all the pupils in the various grades are shown in Table V. The data given in this table show some astounding individual differences. For instance, the lowest score in the fourth grade is less than one-sixth of the highest score in the same grade; 60% of all the pupils in the fourth grade made a better score than the poorest score in the eighth grade; 17% of all the pupils in the fourth grade made a better score than the norm for the eighth grade; while all the pupils, except six, in the fourth grade made a better score than the lowest score in the seventh grade. In general, the highest score made in each grade is approximately 200% of the norm for that grade; while in three grades, IV, V, and VII, the lowest score is less than half the norm.

"Since reading is fundamental and basic to most of the other studies in the school, this wide variation in individual scores indicates the complexity of the problem confronting the class-room teacher. Why did the poorest fourth grade pupil make only a score of 3.9, and the best one make 24? Is one endowed by nature with six times as much reading power as the other? Did the form and manner of instruction in reading fit one six times as well as the other? Or is the wide difference due to other causes? The facts of Table V raise innumerable administrative problems. If the school is to be organized so that each individual pupil may get greatest good from the instruction given, teacher, principal, superintendent, school board, and community must realize this wide variation and coöperate in the organization and administration of a system which takes individual differences into consideration."

TABLE V.—INDIVIDUAL SCORES BY RANK ORDER, GRADES IV TO VIII

Kansas Silent Reading Test

Grades

Pupil	IV	V	VI	VII	VIII
1	24.0	28.1	34.6	32.6	34.6
2	21.7	25.4	32.2	28.3	34.6
3	20.3	23.3	26.3	24.1	31.6
4	19.9	22.3	24.0	22.3	31.6
5	19.7	22.3	23.4	21.3	30.3
6	18.4	21.4	22.5	20.7	28.3
7	16.7	21.4	22.3	20.0	27.3
8	16.7	19.7	21.0	19.3	26.3
9	15.5	19.3	20.1	18.5	22.3
10	15.1	18.4	19.1	17.7	21.7
11	15.0	18.3	18.4	17.7	20.7
12	14.8	17.3	18.1	17.7	19.7
13	14.4	17.1	17.5	17.4	18.6
14	13.4	16.1	16.1	17.1	18.4
15	13.1	16.1	14.8	16.1	15.4
16	12.8	15.8	14.8	15.8	13.8
17	12.8	15.4	14.4	15.7	13.0
18	12.5	13.4	14.4	15.1	12.3
19	11.3	13.4	14.3	14.1	
20	11.2	12.9	13.8	13.2	
21	10.4	12.6	13.5	11.5	
22	9.0	12.4	13.4	11.2	
23	9.0	12.4	13.2	10.6	
24	8.9	12.2	12.8	10.6	
25	6.2	11.7	11.1	8.8	
26	6.2	10.6	10.9	8.8	
27	6.2	10.6	10.7	8.8	
28	6.2	8.9	9.1	8.1	
29	5.7	8.7	8.5		
30	3.9	8.5	8.4		
31		8.5	8.1		
32		6.3			
Average	13.0	15.7	16.8	16.5	23.4

THE USE OF THE A. D. AS A MEASURE OF INDIVIDUAL DIFFERENCES

We have seen thus far that the average is not a sufficient measure for presenting the proficiency of a group of individuals.

And in Lesson 19 some of the advantages of the average deviation were presented. The subject warrants further consideration.

The average of the initial trials in the case of the ten individuals recorded in Table III is 263; the average deviation is 118. The average of the final trials is 55 and the average deviation 12. Knowing the A. D. as well as the average for the initial and final trials in the mirror-drawing experiment we can readily determine, if we do not have the original data, that there was a very great variation in the individuals at the start, and still considerable difference in their proficiency at the end of the practice. We know that the ten individuals differed on the average 118 units from the average of 263 units. We know now for certain that the average does not represent what all ten individuals did. Far from it. Some must have varied above and below 263 by more than 118 in order that the average of all the deviations should be 118. On the other hand we can tell, by knowing that the final trial averaged 55 with an A. D. of 12, that the ten must all be fairly close to the average, probably none varying more than three times the A. D. or by more than 36. That is, no record would probably be better than 19 (55 − 36) or poorer than 91 (55 + 36). (As an actual fact among 56 men and women the best record has been 33 (55 − 2 times the A. D.) and the poorest was 118 (55 + 5 times the A. D.). But there are only two records in the 56 which are poorer than three times the A. D. (i. e., 91)—one being the 118 already referred to and the other being 93.)

In a similar way the A. D. may be determined for the data in Table V concerning the silent reading ability of children in the five grades. We then have:—

Av. Score, Silent Reading........	Grade IV	13.0	A. D.	**4.2**
Av. Score, Silent Reading........	Grade V	15.7	A. D.	**4.5**
Av. Score, Silent Reading........	Grade VI	16.8	A. D.	**5.3**
Av. Score, Silent Reading........	Grade VII	16.5	A. D.	**4.5**
Av. Score, Silent Reading........	Grade VIII	23.4	A. D.	**6.4**

The presence of these average deviations helps us considerably in estimating how much the various children in the two classes differ from their average.

The more one uses this measure—the A. D.—the more it comes to mean; but still it never does tell as much as one can

read from the original data themselves when displayed in tabular form as in Table V.

Relationship of Initial and Final Ability

When the ten individuals are arranged in "order of merit" according to initial and final ability it is clear that on the whole those who are best at the start are best at the end. G is markedly an exception to the rule, starting at sixth place and ending first. H also gains four places, progressing from tenth to sixth place. G was actually a student of markedly superior ability, but noted for awkwardness of movement. He tackled the experiment with misgivings as to his ability to do it thinking it was largely a feat of arm movement. He learned very rapidly and surprised himself with his performance.

Knowing nothing of these ten individuals but their initial scores, it would be safer to hire the first two to work in a store or on a farm, than the last two. This is true, because the test does measure general ability to some extent. But because the test is far from a perfect measure of ability, individuals hired on the basis of it would not always come up to expectations. This we see in the case of G, who, on the basis of the final score, is better than either B or I.

LESSON 22

HOW DO DIFFERENT GROUPS OF INDIVIDUALS DIFFER WITH RESPECT TO LEARNING SIMPLE ARITHMETICAL COMBINATIONS?

In this lesson we shall devote our attention to how individuals differ in the simplest processes of arithmetic, i. e., simple addition and simple multiplication. Some of the questions involved are: How do I differ from other adults in a working knowledge of the multiplication table? Am I more or less rapid in my work than the average adult? Am I more or less accurate than the average adult? How do adults differ from children in these respects? How do children differ among themselves? Besides ascertaining some of the facts in these cases, we shall commence to ask ourselves the further question—what is the cause of these differences?

First of all the members of the laboratory section will use the B-Test blank, on which appears eighty simple problems in addition, such as $\begin{array}{c}4\\ \underline{7}\end{array}$ $\begin{array}{c}1\\ \underline{3}\end{array}$, etc. The class will be given one minute in which to do as many of these problems as they can do. After that the class will be tested as to their proficiency in multiplication, using the BX-Test blank. The papers will then be scored and the averages and average deviations of the two tests worked out for the class. When that is finished the laboratory pairs will proceed as usual by themselves, taking up the various parts of the assignment in order and doing as much as they can during the remainder of the hour. As each part is finished it will be advisable for the members of the class to consult with the instructor in order to make sure that they have understood the instructions and have executed them properly.

Problem.—How do adults differ as to their ability to solve simple addition and multiplication problems?

Apparatus.—A B-Test and a BX-Test blank, watch.

Procedure.—When all in the laboratory section are ready, turn face down the page on which the B-Test is given. The instructor

will give two signals, "Get Ready," and "Go." At the latter signal, turn the sheet over and solve as many problems as you can during the one minute allowed you. At the signal, "Stop," *stop* your work wherever you are and hold up your right hand, so that the instructor can have visible proof that you have actually stopped. (These instructions you will undoubtedly have cause to use later on yourself, as a teacher. You now have an opportunity to know how it feels to take a test of this sort.)

B Test—Addition

Name.............................Age.......Grade...............

3 11 —	0 8 —	3 2 —	11 7 —	12 4 —	9 0 —	7 8 —	6 5 —	4 8 —	2 1 —
8 12 —	5 1 —	8 0 —	12 5 —	6 10 —	9 5 —	2 10 —	11 3 —	12 1 —	0 7 —
1 8 —	10 7 —	4 12 —	9 1 —	6 6 —	7 3 —	12 9 —	1 4 —	7 12 —	6 1 —
7 2 —	6 11 —	4 7 —	9 6 —	10 3 —	2 6 —	1 9 —	10 6 —	8 3 —	5 10 —
0 3 —	8 4 —	10 10 —	7 11 —	3 3 —	6 2 —	5 5 —	4 3 —	8 5 —	3 6 —
11 4 —	7 7 —	0 11 —	9 10 —	11 11 —	4 0 —	8 8 —	5 4 —	8 9 —	6 7 —
3 12 —	10 1 —	3 7 —	0 2 —	12 8 —	1 5 —	9 9 —	1 0 —	4 9 —	5 0 —
12 11 —	5 9 —	2 2 —	11 8 —	2 5 —	0 12 —	2 11 —	4 4 —	10 11 —	2 9 —

BX-Test—Multiplication

Name................................Age..................Grade.....

3	0	3	11	12	9	7	6	4	2
11	8	2	7	4	0	8	5	8	1
8	5	8	12	6	9	2	11	12	0
12	1	0	5	10	5	10	3	1	7
1	10	4	9	6	7	12	1	7	6
8	7	12	1	6	3	9	4	12	1
7	6	4	9	10	2	1	10	8	5
2	11	7	6	3	6	9	6	3	10
0	8	10	7	3	6	5	4	8	3
3	4	10	11	3	2	5	3	5	6
11	7	0	9	11	4	8	5	8	6
4	7	11	10	11	0	8	4	9	7
3	10	3	0	12	1	9	1	4	5
12	1	7	2	8	5	9	0	9	0
12	5	2	11	2	0	2	4	10	2
11	9	2	8	5	12	11	4	11	9

Trade papers with some other member of the class. The instructor will then call out the correct answers to the addition problems. Every mistake on the paper before you should be indicated by drawing a conspicuous circle around it. Indicate at the top of the page the total number of problems performed, the number incorrect, and the number correct. A convenient form for doing this, "65 − 3 = 62," or "60 − 0 = 60," where the first number indicates the number performed, the second the number wrong, and the third the number correct.

Return the papers to their owners, who then may look them over to see if they have been corrected properly. In case of a controversy the scorer should be the final judge. Ambiguously written figures should be scored against.

Repeat the above with the BX-Test blank to test ability in simple multiplication.

Results.—The instructor will now record the data of the two tests on the board and with the aid of the class determine the averages and average deviations of the class. Any errors characteristic of the class should also be recorded.

Interpretation and Application.—Combine into one general discussion at the close of your report the interpretations and applications to this problem and those that follow.

Part No. 2

Problem.—How do adults differ from 4th Grade children in their ability to solve simple multiplication and addition problems?

Apparatus.—The data in Table VI.

Table VI.—Showing Average Number of Addition and Multiplication Problems Solved Correctly in One Minute by Adults and 4th Grade Children in 10 (and 14) Trials on Different Days

Trials	Addition (B-test)		Multiplication (BX-test)	
	Adults	4th Grade Children	Adults	4th Grade Children
1	59	19	40	11
2	67	21	50	15
3	69	22	52	16
4	69	23	55	17
5	71	25	58	19
6	72	26	61	20
7	74	27	61	21
8	75	28	62	21
9	75	29	64	23
10	76	30	64	24
11		31		25
12		32		26
13		32		27
14		33		28

Note.—The children were allowed two minutes instead of one minute to work at the blank. Their records are expressed in terms of what they did in 1 minute i. e., half of their 2-minute record.

Procedure and Results.—Plot these data. Arrange your vertical scale so that it will extend from 0 to 80. Connect the points on the addition curves with a solid line, and the points on the multiplication curves with a dotted line.

Part No. 3

Problem.—How do normal 4th Grade children differ from badly retarded children of the same age in their ability to solve simple addition problems?

Apparatus.—The data in Table VI and the following information: A class of 2B Grade children were tested by M. Phillips with the B-Test. These children averaged 9½ years (just what the usual 4th Grade averages). They had repeated the work of the first and second grades several times and were considered by the authorities to be practically hopeless. They were put (1) through the B-Test on ten successive days; (2) through the C-Test (identical to the B-Test except for the combinations which were new) on ten more days; (3) given 10 minutes drill on 15 successive days on the problems of the B-Test; and (4) again given the B-Test for 10 successive days. Parts (2) and (3) represent 170 minutes drill devoted to simple addition problems distributed over 25 days. The average records of the class in parts (1) and (4) with the B-Test are as follows:—

Trials	Part 1	Part 4
1	4	7
2	5	8
3	5	8
4	5	9
5	6	9
6	6	10
7	6	10
8	6	10
9	7	11
10	7	11

Procedure, Etc.—Handle these data as in Part 2. Bear in mind that the averages (i. e., *norms*) for a Demonstration School and for adults were as follows:

Grades	Norms in Addition (B-Test) Oct., 1915	Feb., 1917	Norms in Multiplication (BX-Test) Oct., 1915	Feb., 1917
III	..	15	..	6
IV	19	29	11	20
V	26	37	17	26
VI	..	40	..	25
VII	18	44	27	27
VIII	20	43	30	30
IX	..	49	..	30
Adults....	59	59	40	40

The differences in the norms on the two different dates is due, first to the fact that in the second case the grades had had three months more schooling by February than in October and, second, to the fact that during the interval a considerable amount of time was spent in the school speeding the children up. That this was very much needed is clearly apparent from the figures. In justice to the Demonstration School it should be noted here that the first set of norms was taken very shortly after the opening of the school and the poor work represented the training these children had received prior to entering the school.

Procedure and Results.—Plot the learning curves of the mentally defective children on the same graph as your other curves.

NOTE: In these experiments the same blank was used each day. Some of the learning consists in more or less learning of answers in a regular order. If a different arrangement of the little problems had been presented each time, the curves would not have gone up so rapidly.

Interpretation of the Three Parts to This Problem.—What do you deduce as to how various classes of individuals differ with respect to learning simple addition and multiplication combinations? Have these three groups of individuals become more or less alike as the result of ten days' practice? What effect has this fact upon our present plan of school administration?

Application.—Hand in your report at the next class-hour.

LESSON 23

THE THREE CAUSES OF INDIVIDUAL DIFFERENCES—ENVIRONMENT, HEREDITY, AND TRAINING

We have noted already that all individuals are alike in that they profit by practice; that they show greater gain at the beginning of practice than at any later time; and that the rate of improvement is irregular, an individual showing remarkable gains with certain trials and equally surprising "slumps" with other trials. We have also noted that individuals differ as to (1) initial performance, (2) final performance, and (3) the amount of improvement resulting from any given amount of practice. Let us now consider these differences in greater detail.

Environment, Heredity and Training

A human being may be thought of, first of all, as being produced by the two factors—*heredity* and *environment*. He is a living organism that *reacts* to the *stimuli* that confront him in life. The stimuli (environment) are the immediate cause of his reactions—*they initiate the reaction but they do not condition that reaction.* In other words, the environment brings about reactions but what those reactions are are determined by the laws of the organism itself. What a person does during any day of his life is determined by his environment, then, and by his innate life. If it is summer time and there is a swimming hole in the vicinity, he may or may not go swimming. If there is no other factor in his environment, such as a dance, to lead him to do otherwise, he quite likely will go swimming. Yet he may not. Some individuals do not respond to a swimming stimulus by going in swimming. Their natures are so constituted that they do not receive pleasure from such experience and so do not seek it. One of the writer's boyhood friends—the best pitcher in town—never went swimming. He didn't enjoy it. In the Holmgren test for color blindness one is given a hundred or more different colored skeins of yarn. He is then given a large skein

of red yarn and told to pick out all the little skeins of similar color. The ordinary individual picks out only red skeins. But a color-blind person picks out not only red but also brown and gray skeins. And if there happens to be a green skein of the same brightness as his red standard he will pick this out also. The same stimulus leads to two quite different reactions here. The reactions are different because of the difference in the development of the eyes of the two individuals. The eyes of one individual are so constituted that red and green are distinguished apart; the eyes of the other individual are so constituted that red, gray, and brown, and even a green, with the correct brightness, appear alike. We may say then again, that the stimulus (environment) is the immediate cause of a reaction, but the innate make-up of the individual (heredity) determines what the reaction shall be.

In the case of our mirror-drawing experiment, the stimulus was the same for all ten individuals, but their reactions differed very materially. Some were very accurate and quick in reacting, some were accurate and slow, some were inaccurate but quick, and some were inaccurate and slow. At first thought we might imagine that the individual differences in this experiment were all due to heredity, since the stimulus was alike for the ten individuals. But such a statement is not so exact as we shall desire here. Suppose one of the ten individuals had practiced with the apparatus at some previous time. Would it then be fair to say that he did better than the others simply because of heredity? Certainly not. We must then introduce a third factor into the discussion—the factor of *training*. Training may be thought of in this connection as the habits the individual has accumulated from previous experiences in life. Every time we react to a stimulus we add a new element to our mental make-up. And so we may think of ourselves as being made up of pure hereditary influences plus habitual influences. How we react, then, toward the swimming hole stimulus is dependent (1) upon the entire stimulus comprising swimming hole, dancing possibilities, etc.; (2) upon our original nature given us by heredity, and (3) upon the sum total of our experiences in life, our training. This factor of training is, of course, a mixture of heredity and previous environment which now affects the organism's reaction to his immediate environment.

Consider the case of a baby who has commenced to talk and already knows a "goose" but no other bird, and the word "dress" but none other to designate clothing. Standing on the porch one day, she observes a pigeon up above her preening its feathers. Finally a feather drops out and flutters to her feet. She picks it up and holding it out to her mother to admire, exclaims, "Goose's dress." The reaction, "Goose's dress," is then initiated by the feather falling at her feet. Original nature is responsible for the responding to the small object by picking it up, also by desiring to talk about it. But previous training determines that the particular words that are used are words already learned. All three factors contribute then to the reaction. *What we do at any moment in life is due to the interplay of these three factors:* (1) *the stimulus confronting us;* (2) *our own original nature inherited from our ancestors, and* (3) *our own acquired habits, the result of previous experiences.*

Before considering the individual differences which we have discovered in the mirror-drawing experiment, or the simple arithmetical work, in the light of these three factors, one point needs to be cleared up which may puzzle some.

Learning Curves Based on "Time" versus Those Based on "Amount Done"

In the mirror-drawing learning curves, as one progressed, his curve came down; in the arithmetic test, as one improved, his curve went up. This difference is due to the fact that in the mirror-drawing experiment the results were recorded in terms of *time* (seconds), while in the arithmetic tests the results were recorded in terms of *amount done.* Improvement shows itself either by a decrease in time for doing the same task (as in the mirror-drawing experiment) or by an increase in what is accomplished in the same work-period (as in the arithmetic tests). Now either of these curves can be transmuted so as to appear in the other form. Take, for example, the curve of learning of the 4th Grade children in multiplication (shown in the left-hand curve of Plate XIII). Here we see that the children performed 11 problems correctly on the first occasion, 15.5 problems on the second, etc. They accomplished that much in 60 seconds. At that rate it required 5.5 seconds to do one problem on the first

occasion (i. e., 60 ÷ 11 = 5.5); 3.9 seconds to do one problem on the second occasion (i. e., 60 ÷ 15.5 = 3.9); etc. When these quotients are plotted for the trials we obtain the right-hand curve in Plate XIII. The two curves, then, both record the same facts, although one goes up and the other comes down. With a little practice in thinking in terms of curves this seeming paradox will no longer bother one.

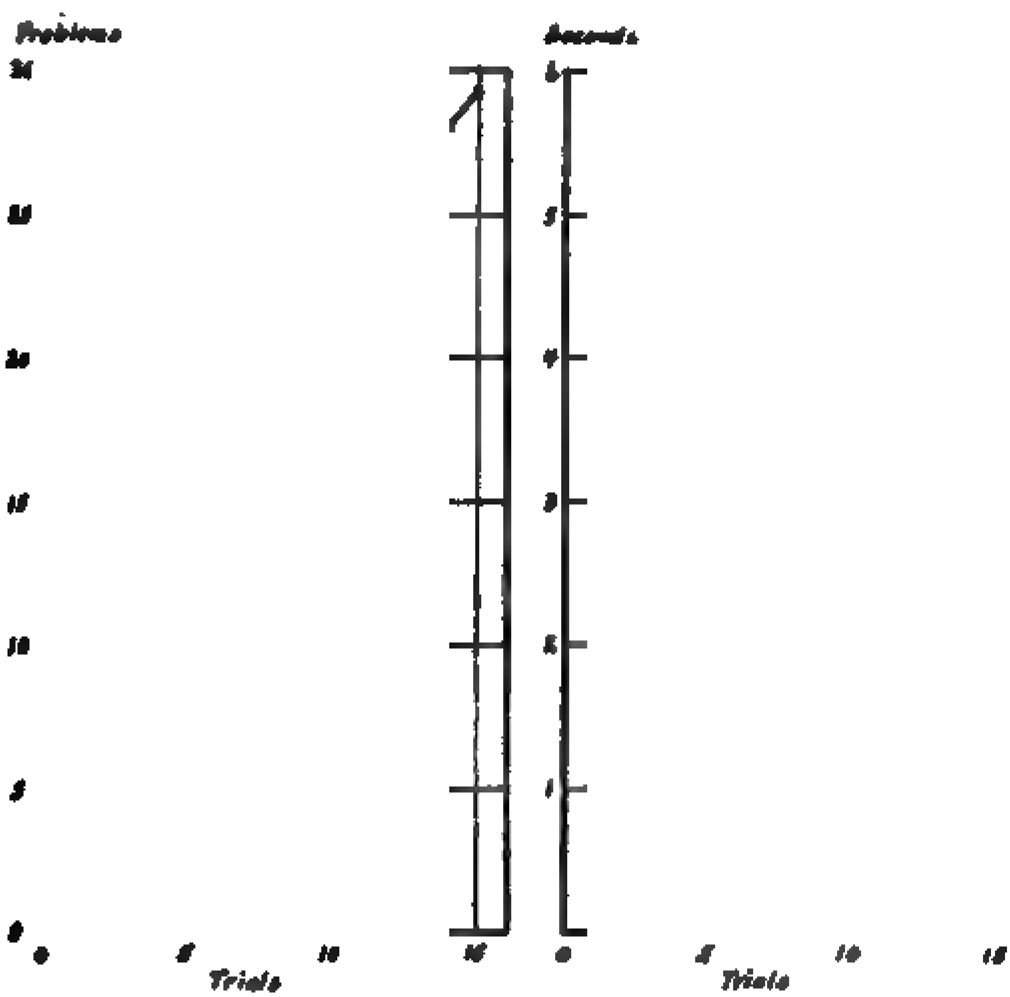


PLATE XIII. -Learning curves of 4th Grade children in multiplication. The left hand curve shows the number of problems solved in two minutes on 15 different days. The right hand curve shows the average time required to do a single problem on the 15 different days. The former records progress in *amount* done, the latter in *time* consumed.

Explanation of Individual Differences in Terms of "Heredity" and "Training"

In the case of the mirror-drawing experiment, or the simple arithmetical work, the stimuli are the same for all the individuals. All the individuals are confronted with the same apparatus or the same blank of 80 problems. In one sense this is not strictly true, as we have already seen, since different individuals respond

to different details in a complex situation. But these differences are not due to actual physical differences in the stimulus, but rather to differences in the individuals themselves. We may then properly speak of the stimuli confronting the individuals as being exactly the same in all ten cases. It then remains to explain the differences in the responses made by ten individuals in terms of "original nature" or "training."

The Effect of Previous Training.—We have learned that all individuals show greater improvement at the commencement of practice than at the end. This being the case *the learning curves of those who have had no previous practice will rise more rapidly and slow up more gradually than in the case of those who have had previous practice.*

This fact may be illustrated in Plate XIV by saying that the person who has had no previous practice (training) would have the learning curve marked B. The person with previous training might have instead a curve similar to A. The former's curve would show very marked gains at the start and would show a large improvement altogether. The latter's curve would not show such a marked gain at the start and would not show such a large total improvement. We may think of A's curve as not being complete—that the first 15 trials are not shown here (have ing been performed before) and that what is represented is trials 16 to 41. This is on the assumption that A and B are exactly identical in every respect. This is further shown in the two curves by representing B's progress in trials 16 to 26 as exactly equal to A's progress in trials 1 to 11. And if the curves were continued, B's progress in trials 26 to 41 would be identical to A's records in trials 11 to 26. *Previous training, then, affects an individual's learning curve by raising its starting-point and by eliminating to some extent at least the ordinary big rise at the start.*

It was stated above that B would show *apparently* greater improvement than A. The word "apparently" should be emphasized. Plate XIV is so drawn as to indicate that although B's curve shows a greater gain than A's curve when measured in terms of improvement in problems performed correctly (i. e., 5 problems to 33.0 problems as against 29.2 problems to 35.9 problems), yet in terms of number of trials B has not gained over A. B started out 15 trials behind and remained 15 trials behind to the end. If B's curve were extended for 15 trials more it

would then reach the point reached by A at his 41st trial—the end of his practice period. It is an extremely difficult matter to measure relative improvement in terms of time or amount of work done, because as one approaches his limit each unit of effort will produce a smaller and smaller gain in time saved or work accomplished.

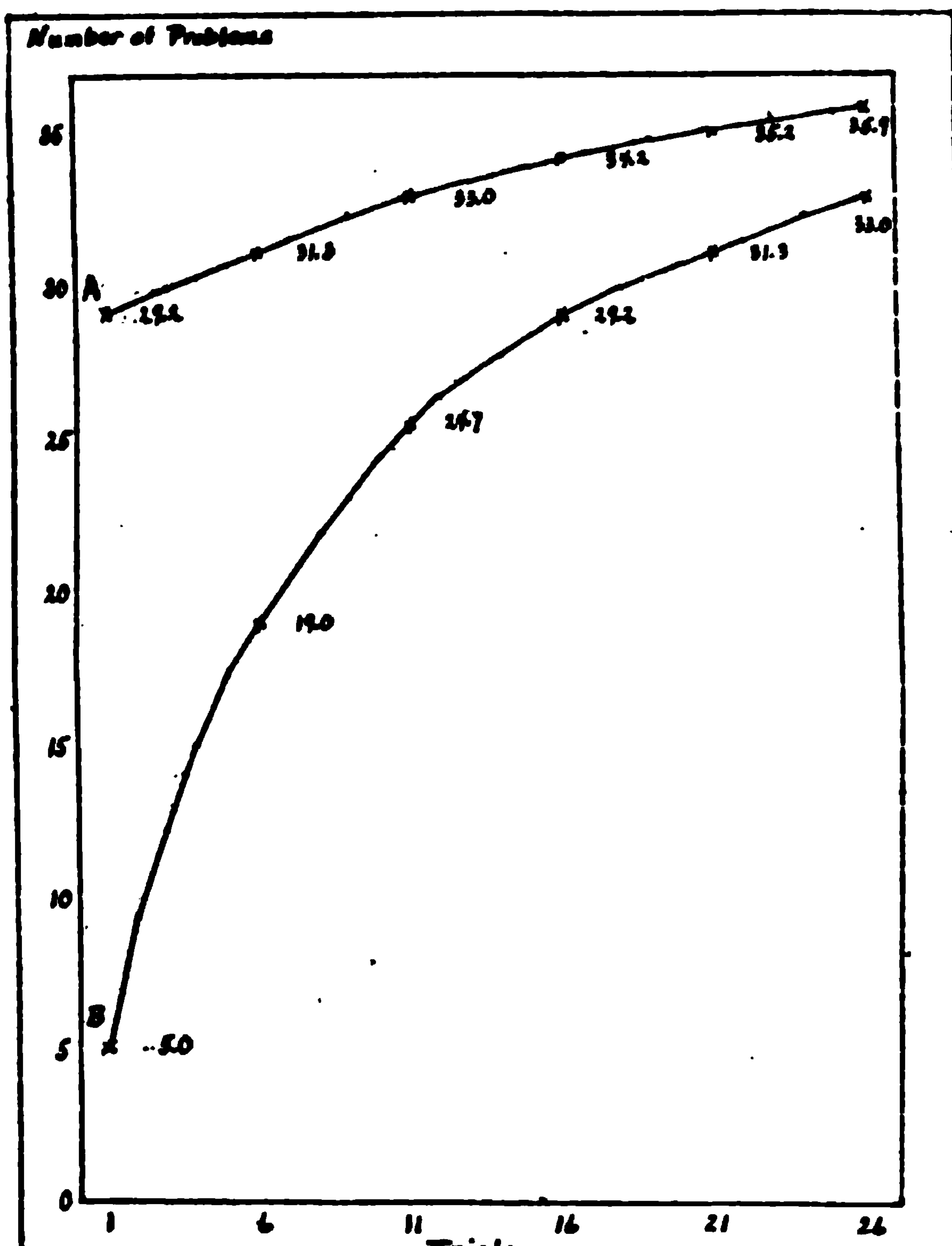


PLATE XIV.—Showing learning curves of two individuals who are identical in all respects save in the amount of training in the arithmetical combinations.

The Effect of Differences in Hereditary Endowment.—How do differences in sheer hereditary endowment affect learning curves? Plate XV illustrates this point. The individual with the best endowment will show the greatest improvement, the person with the least endowment will show the least improvement. Curves B, C, and D represent the learning curves of three persons; curve

B being the curve of the best endowed, curve C being of a poorer endowed person, and curve D being of the poorest endowed person of the three. *The better the original nature of the individual the greater will be the improvement resulting from practice.* These three individuals with equal training and varying degrees of hereditary endowment would not even do equally well, of course, on the first trial, because the better endowed person would do better than the others right from the start.

One warning should be given here. The degree of efficiency of the original nature of the individual must be considered as it applies to the particular task being tested. For example, a great musician (having superior original nature along musical lines) may not necessarily have superior endowment in mirror-drawing. The musician's curve in mirror-drawing will show great improvement or not; depending not upon endowment in general, but upon the endowment which he has that pertains to mirror-drawing.

The Effect of Differences in Training and Heredity Combined.—Now let us consider, third, some combinations of these two factors. We may have four individuals: (1) A having good heredity and previous training, (2) B having good heredity but no previous training, (3) E having poor heredity and previous training, and (4) D having poor heredity and no previous training. (Poor heredity is to be understood as endowment having to do with the trait under discussion; training to be considered in terms of so many units of time devoted to learning specific material.) Then their learning curves would take more or less the forms illustrated in Plate XVI. A and E can be thought of as having had 15 units of instruction, and B and D as having had none. As B is superior to D by hereditary endowment he will do better than the latter at the start and will rapidly leave him behind. (See Plate XV, where this point is alone considered.) The more training they receive the more different will they become as far as this trait is considered, because of the difference in their ability. In the same way A and E, who have had some previous training, become more and more unlike as they continue their training. These curves illustrate, then, the principle that continued training makes individuals of different hereditary endowment more and more unlike. We shall return to this point a little later.

The curves of A and B are symmetrical, A's curve actually being the same as B's from the latter's 16th trial on to what would be his 41st trial. The curves of E and D are also symmetrical in the same way. Because of their previous training A and E will maintain their superiority over B and D, respectively. This superiority seemingly grows smaller and smaller with practice. It actually does if measured in terms of problems

PLATE XV.—Showing learning curves of three individuals with different hereditary endowments.

performed, but it does not if measured in terms of effort, for A always remains ahead of B to the extent of what 15 units of time will produce, and likewise E remains ahead of D to that extent.

The difference between the good heredity of A and B and the poor heredity of E and D is meant to be a considerable difference. Yet it is not exaggerated at all in comparison with the differences

found in almost any class room. The differences between the average of the 4th Grade and the group of retarded children is about equal to that shown here between A and E. In Plate XVII are shown the curves of a child from the 4th Grade and another from the retarded group. The former is not the brightest in that grade (actually rated 11th in a class of 28) and the latter

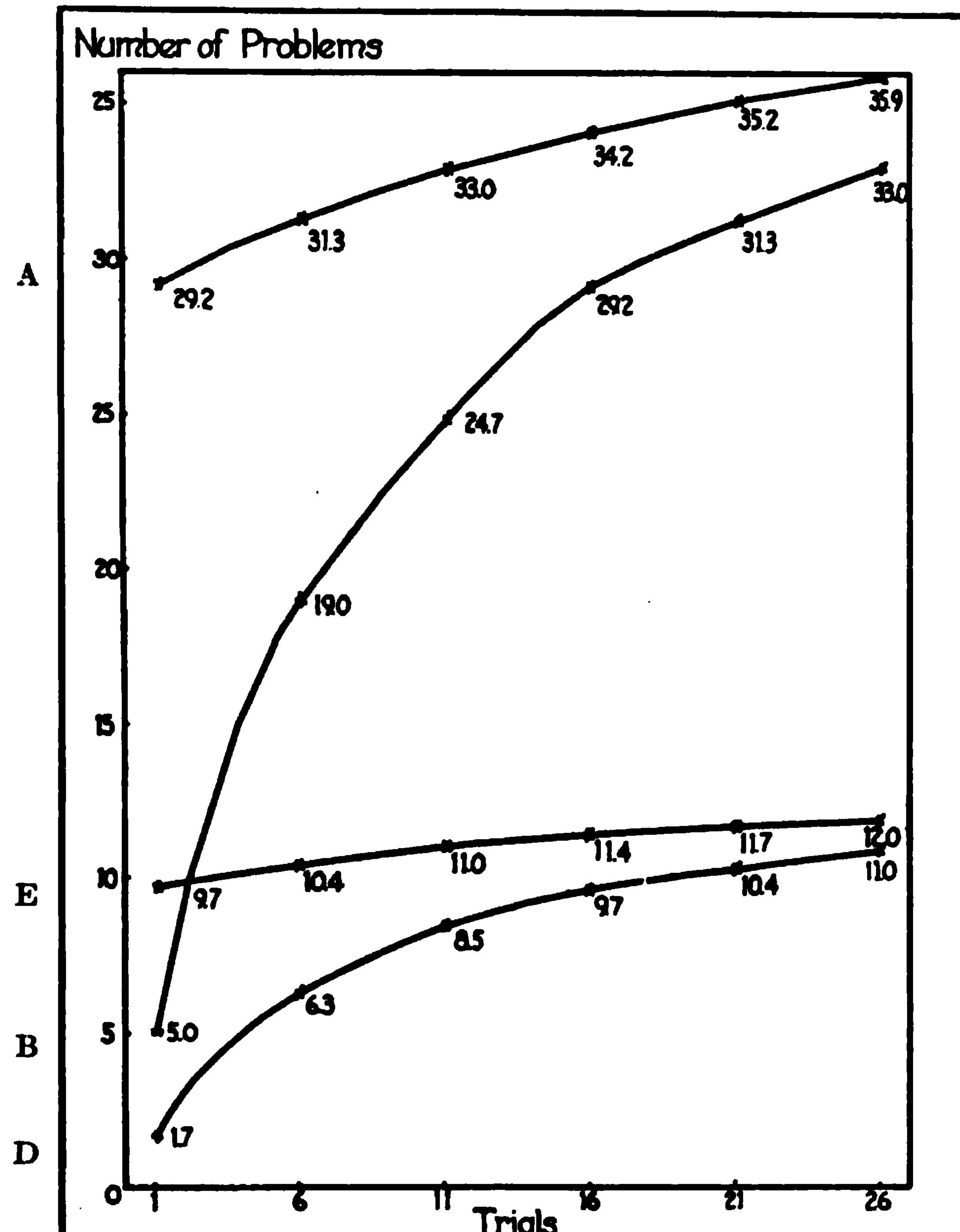


PLATE XVI.—Showing learning curves of four individuals: A with good heredity and previous training; B with good heredity but no training; E with poor heredity and previous training; and D with poor heredity and no training.

is not the dullest among these unfortunate children. In fairness to the records it should be stated that undoubtedly the 4th Grade child practiced on these combinations outside of school. But the dull child had also this opportunity. The curves do epresent cons equently the learning that followed equul stimula-

tions in the school. One child could respond in an adequate manner and did so and the other child could not and so did not. Some students can learn mathematics so that they eventually master calculus and its applications to engineering, while others never get beyond the fundamentals. Some students master the

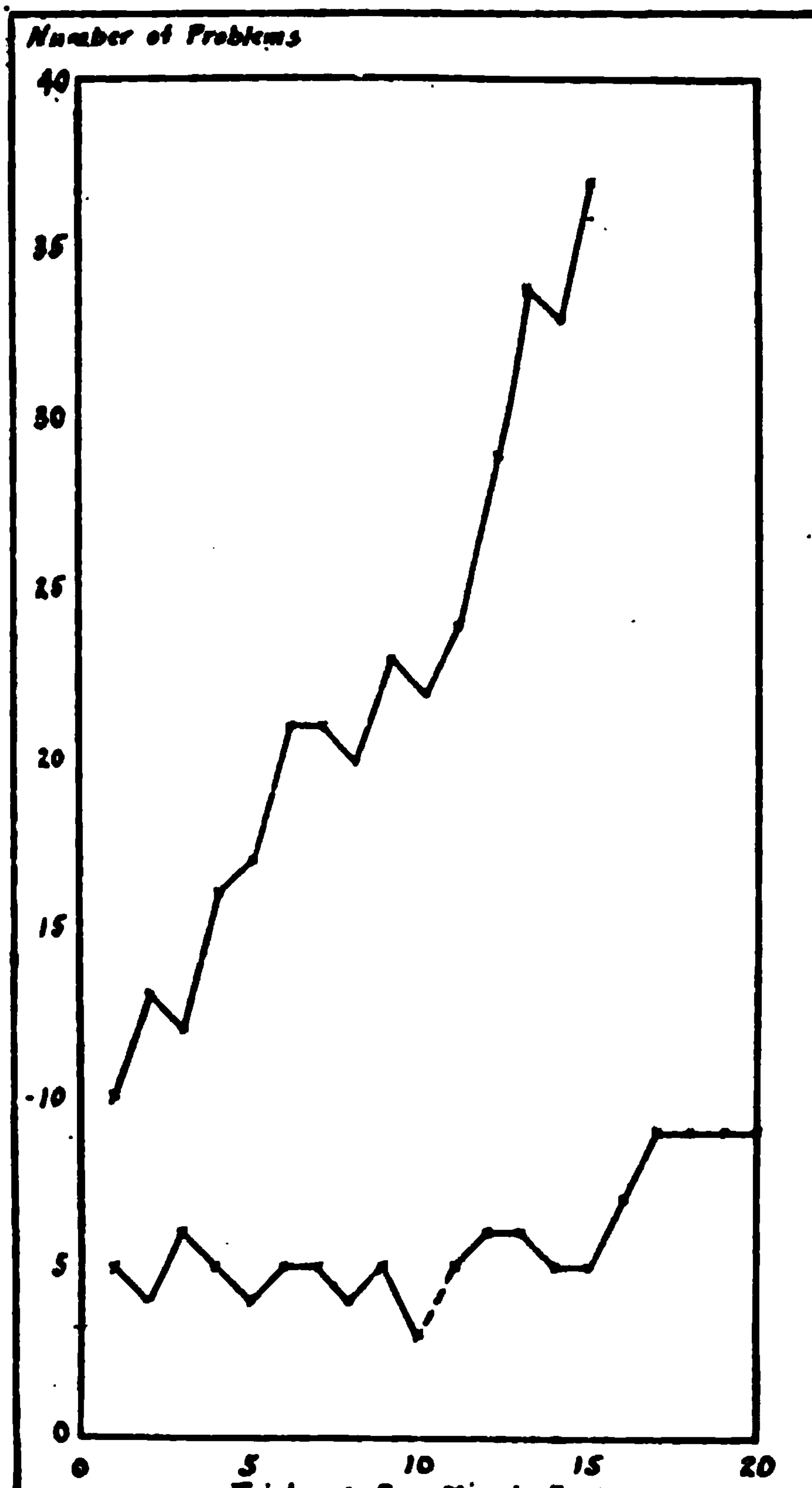


PLATE XVII.—Showing learning curves in solving addition combinations (B-Test) for a bright 4th Grade child and a mentally defective child of the same age. (In the case of the latter between trials 10 and 11 there intervened 170 minutes of drill extending over 25 days on addition combinations.)

principles of art and design and become skilled in dressmaking, millinery, architecture, painting, etc., while others are oblivious to the most atrocious combinations of color or form in their clothes, their home surroundings, etc. The gifted child learns

rapidly and improves tremendously; the child who is lacking learns slowly and learns very little.

Individual Differences in Solving Simple Arithmetical Combinations

Let us now more or less review what has been discussed in this lesson but consider the matter in terms of the data studied in Lesson 22.

These data are plotted in Plate XVIII. The curves do not bring out the points so clearly as do the theoretically constructed curves of Plates XIV, XV, and XVI. Nevertheless they bear witness to all of those points.

1. *The greater the amount of practice the higher the curves start.* This point needs no further discussion.

2. *The greater the amount of practice the less rapid the gain.* This point is true but it does not always appear, due to the presence of conflicting factors. Although none of these groups had had any previous training with the particular tests under discussion, yet we naturally would expect the adults to have had more practice and so to show less improvement than the 4th Grade children. The real cause, however, as to why the curves do not clearly illustrate the point made at the commencement of this paragraph is due to the differences in the groups in terms of heredity. Not only are the adults superior to the 4th Grade children because they have a mature development of their hereditary nature, but also without question a class of college men and women are superior to a class of 4th Grade children. That is, the 4th Grade class will not average as high an endowment when they become adults as do the college students. This class of forty-three college students is probably made up of the superior students from forty-three 4th Grade classes. The great differences in heredity cover up then the effect of much practice versus little practice.

3. *The greater the hereditary endowment the greater the improvement from training.* This point is clear from the curves and from what has just been stated.

4. *The greater the training the more a group of individuals become unlike.* At the commencement of the training recorded here the three groups could perform as follows:

Number of problems solved per minute by college students......	59
Number of problems solved per minute by 4th Grade children......	19
Number of problems solved per minute by defective children......	4
Average	27.3
A. D.	21.1

and at the end of ten practice periods they performed as follows:

Number of problems solved per minute by college students......	76
Number of problems solved per minute by 4th Grade children......	30
Number of problems solved per minute by defective children......	7
Average	37.7
A. D.	25.6

As the A. D. has increased we know the groups are less alike than before. This fact is shown also in this way.

College students are superior to 4th Grade Children at start by 40 problems.

College students are superior to 4th Grade Children at end by 46 problems.

Also—

College students are superior to Defective Children at start by 55 problems.

College students are superior to Defective Children at end by 69 problems.

And—

4th Grade Children are superior to Defective Children at start by 15 problems.

4th Grade Children are superior to Defective children at end by 23 problems.

This fourth fact, that training causes a group to "fly apart," to become more and more unlike, due to the inherent differences in the hereditary equipment of the members of the group, affects our school work most profoundly. It makes clear that no grade can be taught as a class without some members very shortly doing such good work as to tempt the authorities to promote them into the next grade and some other children doing such poor work as to lead to their being put back into the grade below or to force the teacher to give them individual instruction. No mechanical administrative scheme for holding a class together will ever work satisfactorily because the members of that class cannot advance

at the same rate. The solution to this difficulty has not been evolved, but if it ever is, in the writer's opinion, it will include a very flexible scheme of promotion by subject-matter, coupled with extensive provision for individual coaching of children that

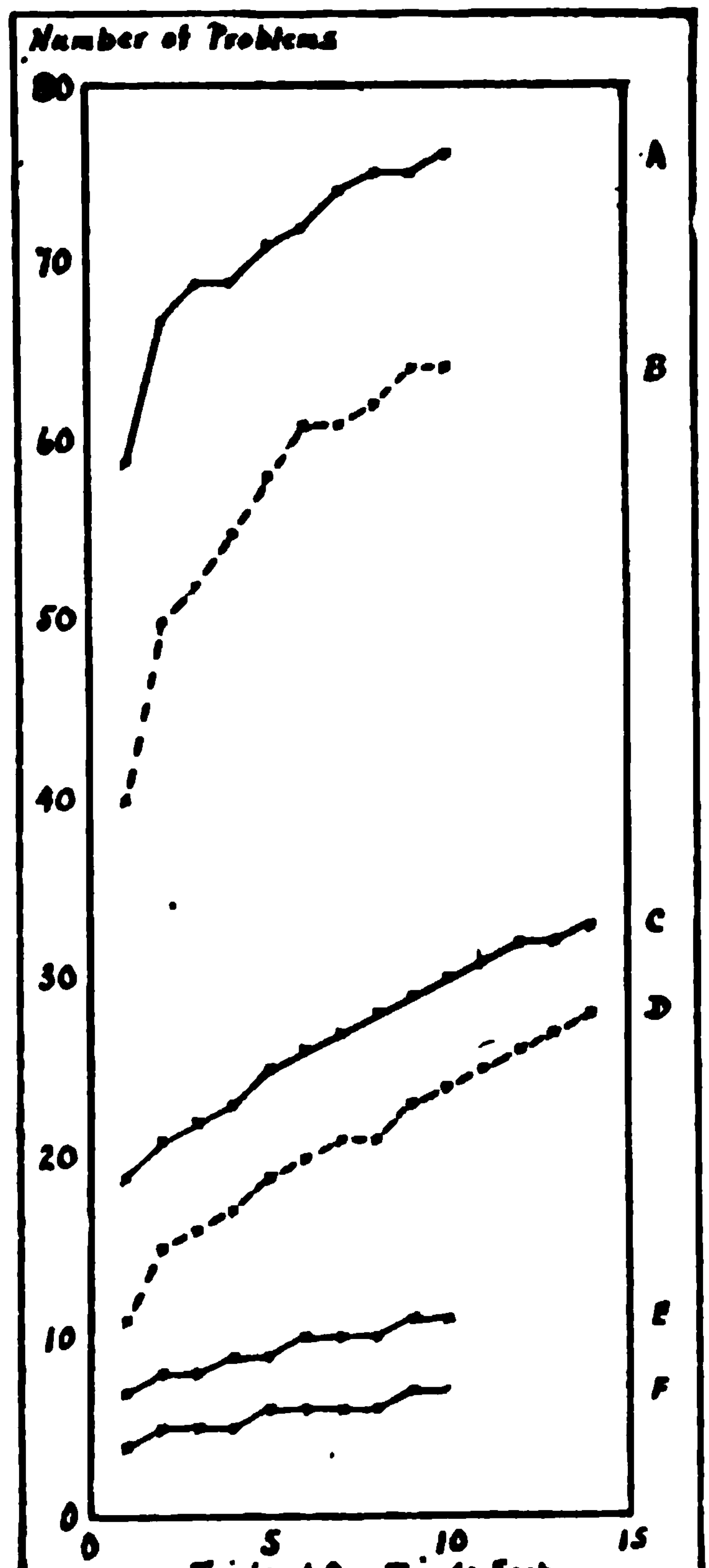


PLATE XVIII.—Showing learning curves in solving simple arithmetical combinations: from adults, Curve A (B-Test) and Curve B (BX-Test) from 4th Grade children, Curve C (B-Test) and Curve D (BX-Test); and from defective children, Curves E and F (B-Test)—Curve F prior to and Curve E after 170 minutes of special drill on addition combinations.)

are markedly behind and markedly ahead of their class. This point will be taken up again later. But right now it should be realized that the main point of the whole problem is that children cannot progress in their learning at the same rate—that some go fast, some go slow, and some advance at average speed.

LESSON 24

THE GENERAL LAW AS TO HOW INDIVIDUALS DIFFER

We know that people are different almost before we realize that there are people. We distinguish between tall people and short people, fat people and thin people, clever people and silly people, and most of us would agree fairly well in our classifications. But how do we draw these distinctions? Do we have hard and fast lines, enclosed between which one class is set off from another? Should we say that all men between 0 inches and 62 inches in height, for instance, are short, and those between 62 inches and 84 inches are tall? That any one weighing under 125 pounds is thin or more than 125 pounds is fat? And even if we decide to be so definite in these cases (though certainly our standard is artificial) where shall we draw the line in the case of mental attainments? Are we all talented or stupid, for example? Or are most of us merely average people without special qualifying adjectives, and the rest of us simply either better or worse than the average? That is, instead of having separate little groups of idiots, normal folks, and geniuses, the members of each class keeping carefully to themselves, do we perhaps have but one class of individuals, all typified by the average, yet all varying from the average in greater or less degree?

We are about to perform an experiment in throwing dice. This is as purely a chance performance as we can get. Let us see if the throws are distinctly different or whether they follow one general law. For example, can we divide the throws into two groups—high and low, or must we think in terms of one group with variations from its average? In any case the results may apply to our biological problem as given above.

THE EXPERIMENT

Problem.—In throwing dice are the totals distinctly different or do they approach a general type?

Apparatus.—Coördinate paper; 3 dice.

Procedure.—*Part* 1. Lay off on your coördinate paper a base line, and number the squares from 0 to 18, as is done in Plate XIX. Lay off a vertical axis and number the squares from 0 to 35 (Plate XIX only shows to 8). Now commence and throw your three dice. Count up the total of the three dice and record that total on your coördinate paper in its proper place. (The writer threw first a 4, 3, and 1, making a total of 8.) A "1" (first throw) is placed in the square on the coördinate paper immediately above the 8 on the scale. A total of 11 was next thrown by the writer and it is indicated by the "2" in the plate. A total of 14 was thrown third, etc. Twenty-five throws are indicated in this Plate, the twenty-fifth throw being a total of 7. Plate XIX shows then that the writer threw

one 6
one 7
three 8's
three 9's
six 10's
three 11's
two 12's
one 13
two 14's
one 15
one 16, and
one 17

Thus 25 throws are distributed or indicated in the plate.

Record in this way 100 throws. Show your completed diagram to the instructor before proceeding further.

Such a diagram is called a *surface of distribution* as it shows just how all the throws were distributed among the possible totals.

Part 2. Now determine how many different totals can be

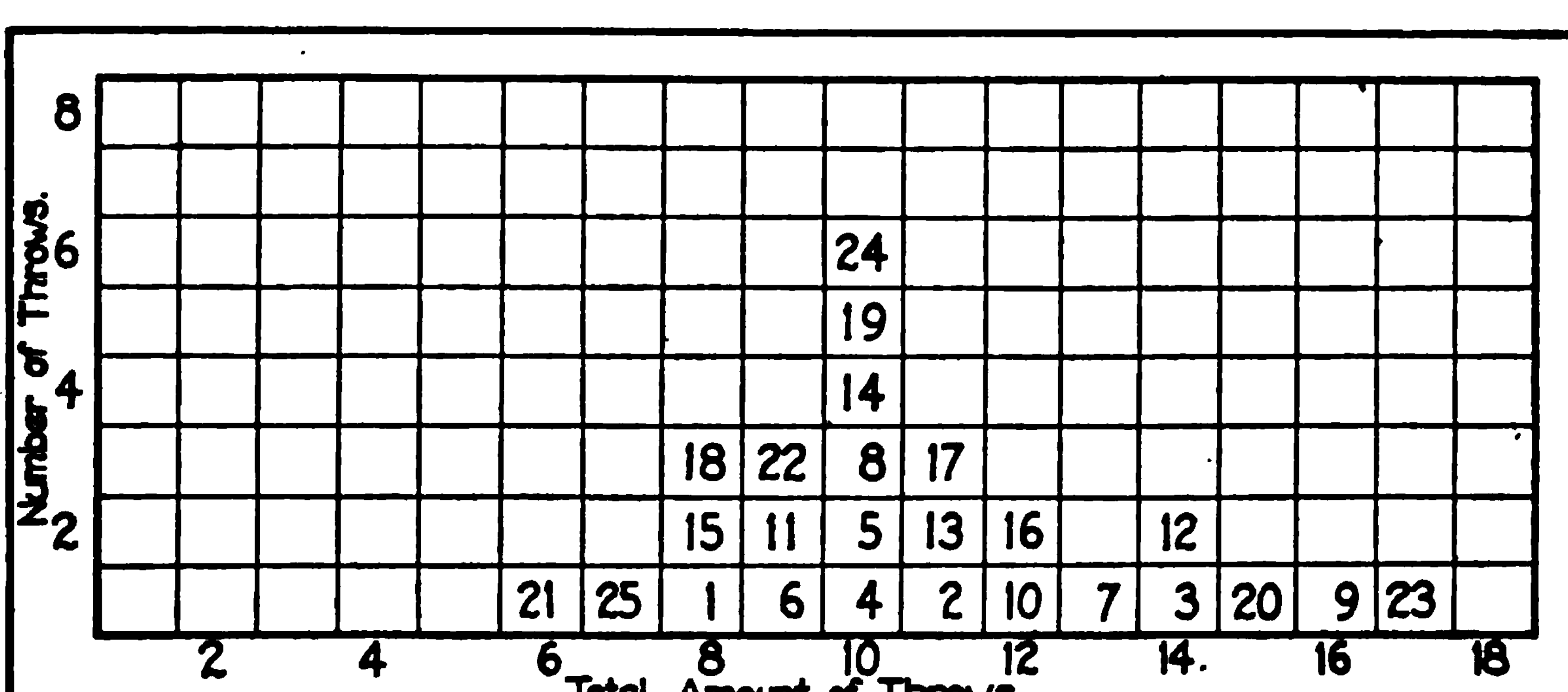


PLATE XIX.—Illustrating by means of a "surface of distribution" twenty-five throws of three dice.

obtained by throwing three dice. (In Plate XIX are indicated 12 different totals, i. e., from a total of 6 to a total of 17, inclusive.) Present your answer to your instructor before proceeding further.

Part 3. Now figure out (a) all the possible different combinations[1] it is possible to obtain by throwing three dice. (Assume one of the three dice is red, another is blue, and the third is white. Then one on the red die, two on the blue, and three on the white is a different combination from one on the red, two on the white, and three on the blue, or from two on the red, one on the blue, and three on the white. The question is, how many different combinations are there?)

Also figure out (b) how many of each total you will obtain when every possible combination is considered.

Part 4. Suppose instead of getting the 100 throws you did get, you had thrown the dice as many times as there are different combinations and in throwing the dice that number of times had got each and all of these different combinations. Plot a surface of distribution to illustrate just this.

Part 5. What relation exists between the surface of distribution you actually obtained by throwing the dice 100 times and the surface of distribution obtained in the preceding paragraph?

What relation do you think there exists between the findings in this experiment of throwing dice and the general problem of how individuals differ? Can throws be divided into two or more groups; can individuals?

Hand in your report at the next class-hour.

[1] Mathematically speaking what is wanted here is permutations, not combinations. That is, in forming combinations we are only concerned with the number of things each selection contains, whereas in forming permutations, we have also to consider the order of the things which make up each arrangement; for instance, if from six numbers, 1, 2, 3, 4, 5, 6, we make a selection of three, such as 123, this single combination admits of being arranged in the following ways:—123, 132, 213, 231, 312, and 321, and so gives rise to six different permutations.

LESSON 25

THE GENERAL LAW AS TO HOW INDIVIDUALS DIFFER (continued)

THE NORMAL SURFACE OF DISTRIBUTION

If one should take three dice and throw them 216 times, each time counting up the total score and plotting this score, one might obtain a surface of distribution somewhat like the three surfaces shown in Plate XX. The first and third were actually so obtained, the middle one is the perfect surface which theoretically chance should give.

One may figure out this theoretically perfect surface in this way. Count up all the throws that are possible and record how many times each total appears. You may have

1 and 1 and 1, a total of 3
1 and 1 and 2, a total of 4
1 and 1 and 3, a total of 5
1 and 1 and 4, a total of 6
1 and 1 and 5, a total of 7
1 and 1 and 6, a total of 8
1 and 2 and 1, a total of 4
1 and 2 and 2, a total of 5
etc.

When you have so obtained all the 216 totals you will find that you have

1 total of 3	27 total of 11
3 totals of 4	25 total of 12
6 totals of 5	21 total of 13
10 totals of 6	15 total of 14
15 totals of 7	10 total of 15
21 totals of 8	6 total of 16
25 totals of 9	3 total of 17
27 totals of 10	1 total of 18

When these data are plotted you have the ideal surface of distribution in Plate XX. All this means that when you throw three dice you are just as likely to get any one combination as

any other. But you are more likely to get a total of 10 or 11 than 3 or 18. You can express this likelihood by the expression 27 to 1, for there are 27 combinations that will give a total of 10 or 11, whereas there is only one combination that will give 3 or 18. Our normal curve of distribution represents then that surface most likely to be obtained by 216 throws. Actually we seldom get exactly that ideal surface, but we do get surfaces that approximate it in general appearance.

PLATE XX.—Three surfaces of distribution obtained from throwing three dice 216 times. The first and third surfaces were obtained from 216 actual throws. The second is based on what theoretically should be obtained from that number of throws.

One may think of this matter of throwing three dice as being conditioned on three independent factors, each one of which may vary independently in six different ways. When the three independent factors with their six possible variations are considered as a whole, we realize that there are 216 independent combinations possible. But the 216 independent combinations do not give 216 different final scores. They give but 16 different scores (from 3 to 18). Nor do the 216 combinations give an equal number of each of the 16 different scores. They give varying numbers of the 16 different scores—only one 3, three 4's, six 5's, etc., as in the table above.

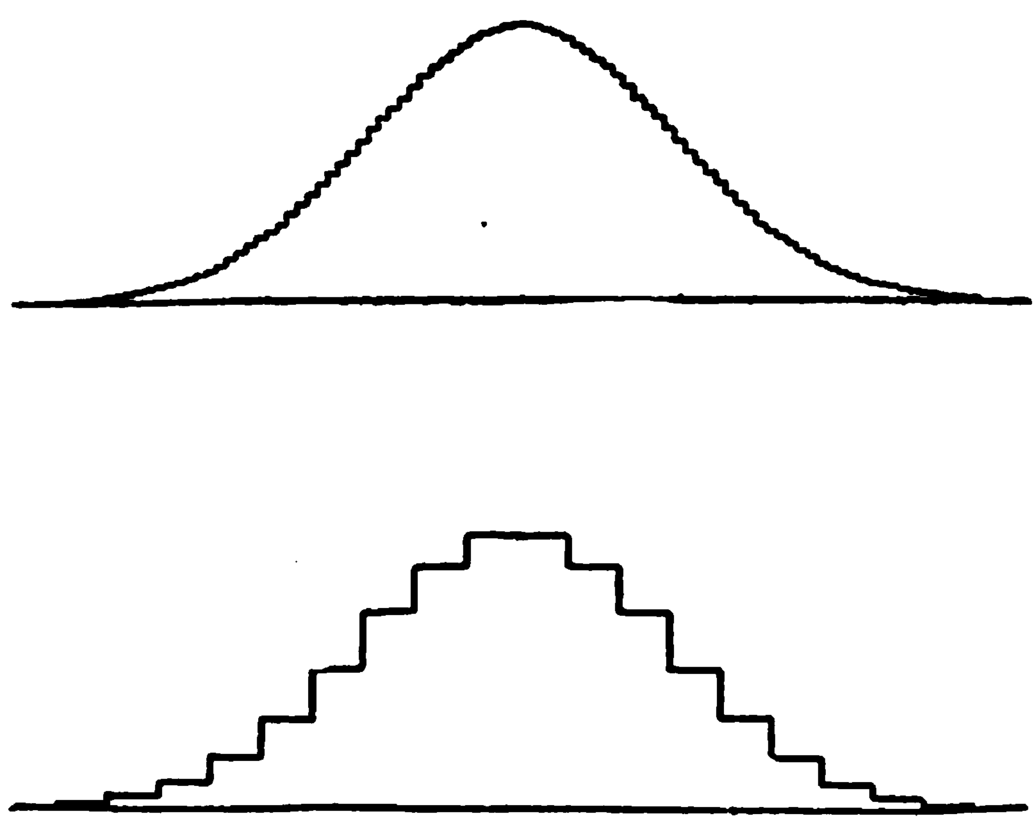


PLATE XXI.—The normal curve or surface of distribution. The two curves differ only in that a coarse unit of measurement was employed in the second case whereas a fine unit was employed in the first case;—i. e., inches vs. eighths of an inch. (From E. L. Thorndike, *Educational Psychology*, Vol. III, p. 334.)

Now in a similar way we may think of the characters of different individuals as the final totals resulting from the interaction of many independent factors, each of which may vary independently in many ways. Instead of there being but three factors with six variations each, which combined give us our human individualities, there are undoubtedly many more than three factors and these factors have many more than six variations. Nevertheless the final outcome is very similar to what we obtain by throwing dice. We find that most of the individuals, just like most of the throws, give us individualities that resemble each other very much, just as the throws of 8, 9, 10, 11, 12, and

13 are very much alike. We find also that occasionally we get very striking personalities, just as very occasionally we get throws of 3 or 4 or 17 or 18. They are striking because they differ so from what we ordinarily have.

In Plate XXI are given two different methods of drawing the typical surface of distribution. In the lower of these two surfaces there was used a very coarse unit of measurement, e. g., inches in measuring height, and in the upper surface there was used a very much finer unit of measurement, e. g., eighths of an inch. We can imagine a surface drawn on the basis of a still finer unit of measurement. In this case the jogs in the line would be very, very small, so that for all practical purposes the line would be a smooth curve and not a jagged line. Such a curve is called the *normal curve of distribution*. In terms of geometry the normal curve of distribution is the limit approached by most surfaces of distribution which are obtained in biological studies.

The Distribution of Individual Differences

An Ideal Distribution.— When we come to study human beings we find that they fit into our normal surface wonderfully well. In fact, the conception has been derived from our study of individual differences. In Plate XXII is shown a normal curve of distribution picturing the different types of individuals according to general intelligence. In the middle are the great bulk (50%) of human beings—average human beings. As we proceed to the left, we have individuals slightly below the average; "dull" persons; morons with intelligence approximately equal to children from 8.0 to 10.0 years;[1] and then imbeciles with intelligence of from 2.0 to 8.0 years; and idiots with intelligence of from 0.0 to 2.0 years. The remaining 0.001% of the inferior population can possibly be thought of as being too inferior to live and so constitute a fraction of those who are born dead. In the same way we may divide up our superior individuals proceeding from the middle group out toward the right. Apparently we have no terms to cover these superior individuals so that the

[1] There is a great deal of controversy today as to what should be the proper mental age limit of morons. Some writers place it as high as 12 years. Experienced based upon testing men in the army makes 10 years a satisfactory figure.

expressions used here have no standard meaning. To the right of the group entitled "National Leaders," comprising 29,000 in a population of 100,000,000, are still 1,000 individuals not to be overlooked. They comprise our most valuable men, our geniuses, etc.

Cattell,[1] in his study of the thousand most eminent men of history, studied a group even more eminent than these since his thousand was not taken from a population of 100,000,000

[1] J. McK. Cattell, A Statistical Study of Eminent Men, *Popular Science Monthly*, Feb., 1903.

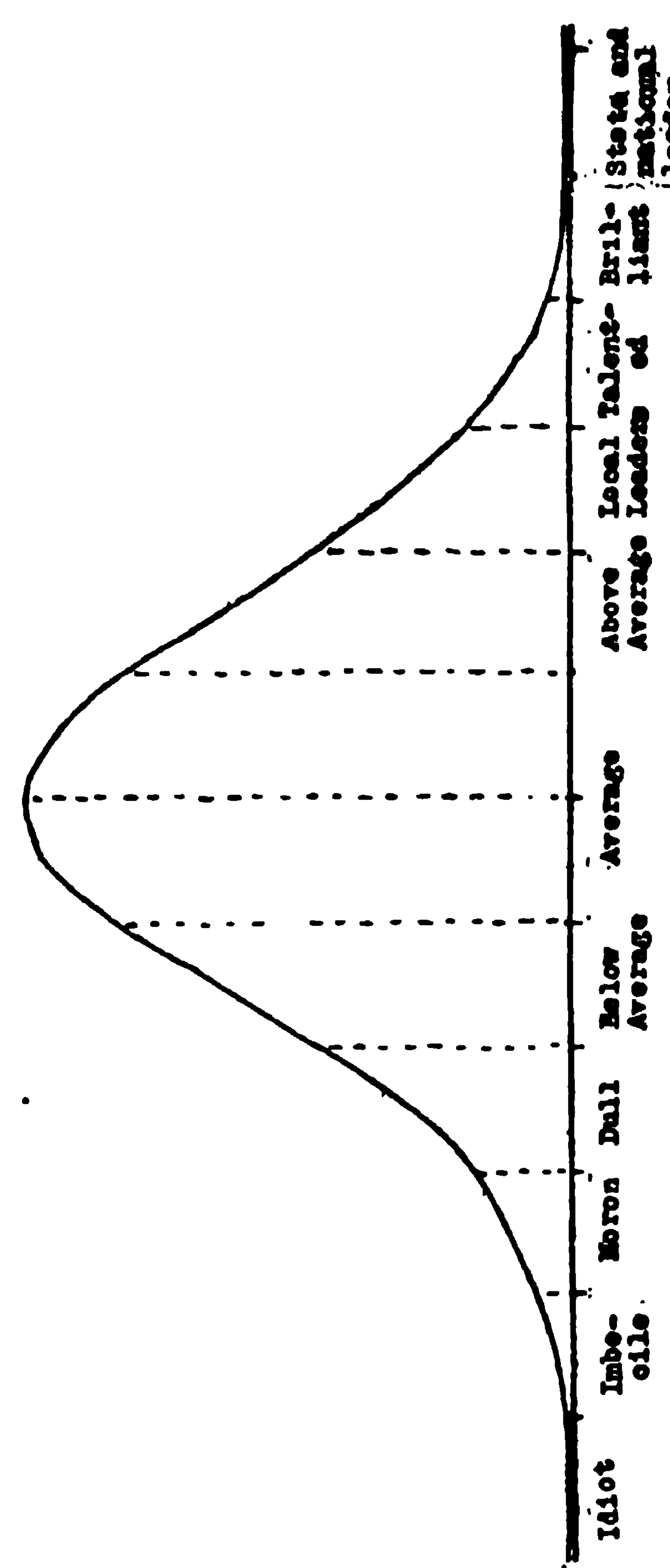


PLATE XXII.—A normal surface of distribution divided up into twelve groups showing eleven degrees of general intelligence (the middle two groups are together considered as typical of average intelligence).

but from the population of the known civilized world. They would be located on this diagram several groups to the right of the group here entitled "National Leaders." According to Cattell the ten most eminent men of all history are the following in the order of their prominence:—Napoleon, Shakespeare, Mohammed, Voltaire, Bacon, Aristotle, Goethe, Julius Cæsar, Luther, and Plato.

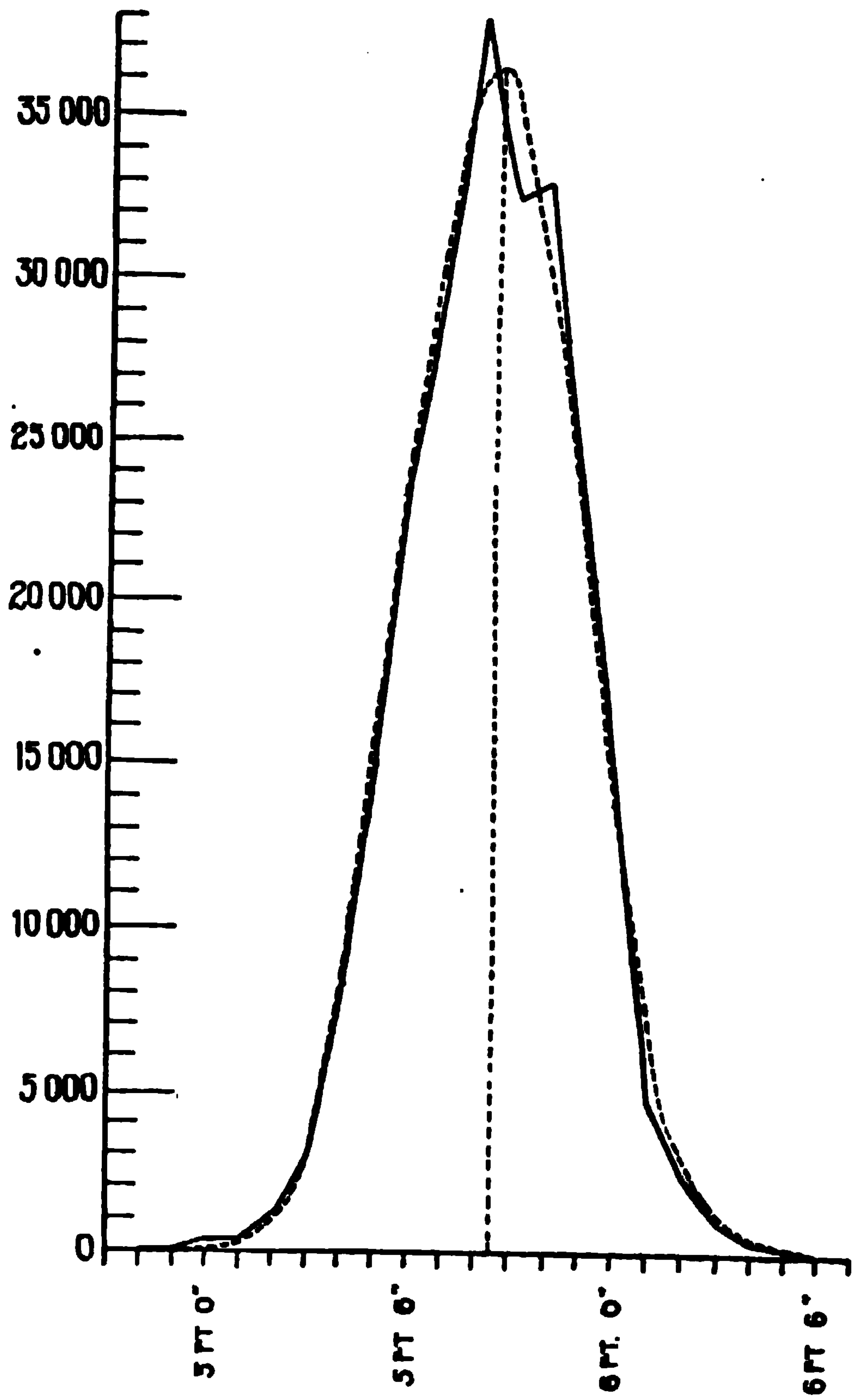


PLATE XXIII.—Showing distribution of height of 221,819 men. (Quoted from note of E. G. Boring in *Science*, Nov. 12, 1920, p. 465f).

ACTUAL DISTRIBUTIONS OF INDIVIDUAL DIFFERENCES

Plates XXIII and XXIV present distributions of physical height and general intelligence. In both these cases the actual distribution very closely approximates to the smooth, normal

curve. They emphasize again that men vary; also that they cluster around one central tendency or type.

In Lesson 21 our attention was called to the fact that the averages of the eight grades of a school may be equal or superior to the norms for those grades, and yet many children in each grade may be in a very bad way educationally. The specific case was mentioned of testing a school with the Kansas Silent Reading Test and the individual scores for all the children were presented in Table V. These scores are again given in Plate XXV, where they are displayed as surfaces of distribution. Because of the

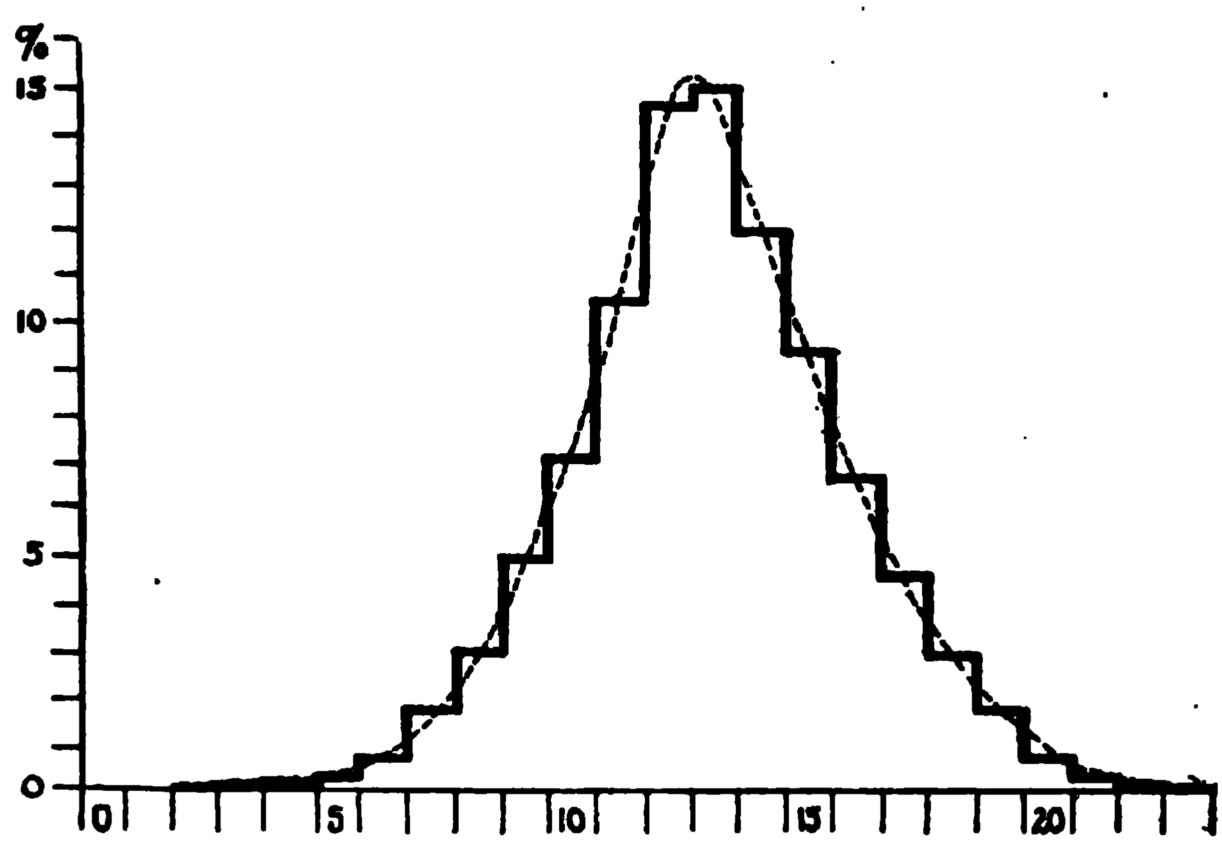


PLATE XXIV.—Showing distribution of 93,965 white men in the army draft in terms of intelligence test scores. (From Memoirs, National Academy of Science, Vol. XV, 1921, p. 653.)

small number of children in any class these surfaces only remotely approximate the form of the surface of distribution which would be obtained if there had been 100 or 200 children in each grade. When the scores from all the children in Grades IV to VIII are combined, as they are in the lower part of Plate XXV, a surface of distribution much more similar to the typical form is obtained. If the scores from the children in Grades I to III had been included the surface of distribution would be still more similar to the usually obtained form. The form obtained here is typical of the form which results from a study of individual differences in nearly all traits, both mental and physical.

During the war a psychological "general intelligence" test was given to hundreds of thousands of the enlisted men and to many

of the officers. Distribution of the scores obtained from enlisted men is shown in Plate XXIV; also again in Plate XXVI, together with the distribution of officers' scores. The two distributions

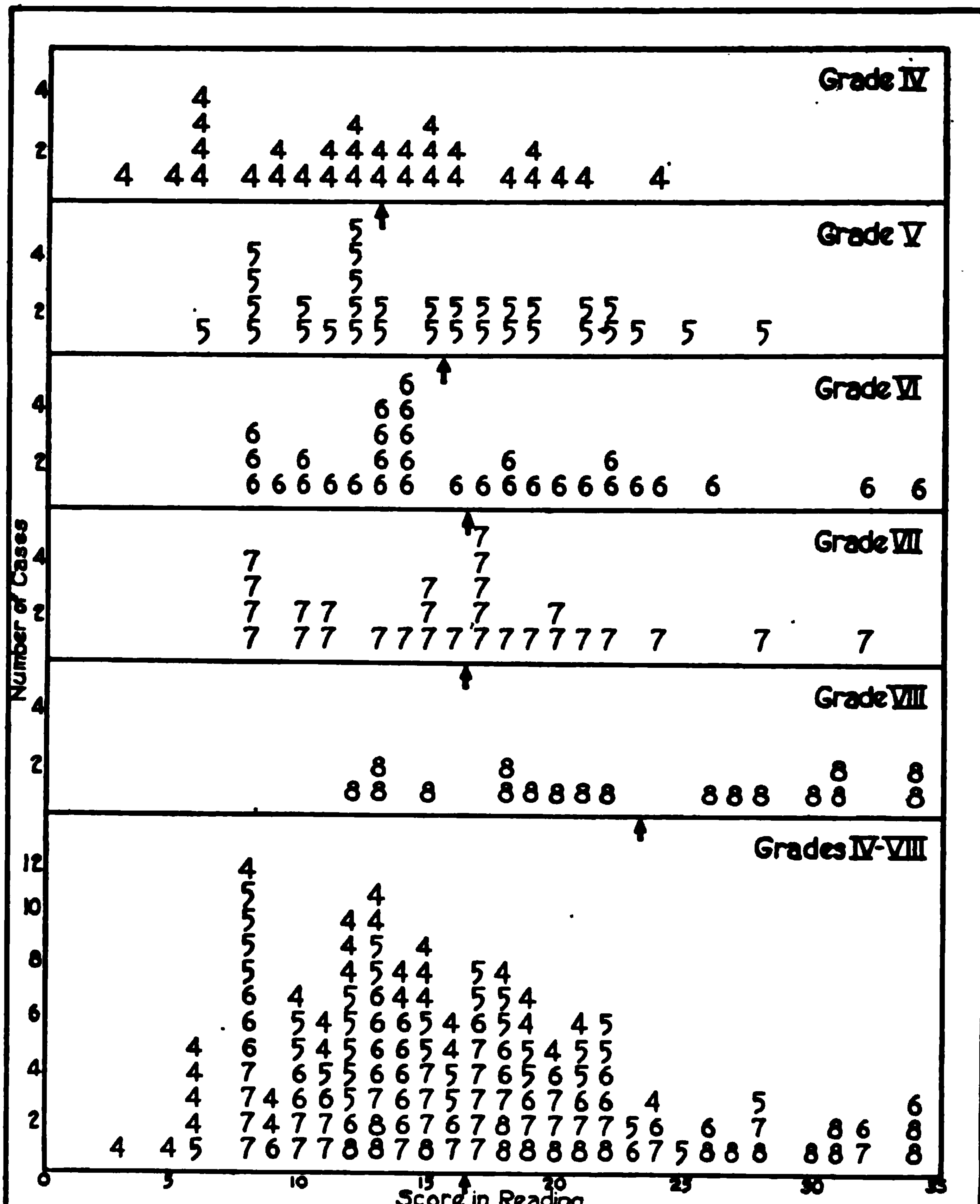


PLATE XXV.—Showing the Distribution of Children in Grades IV to VIII, based on the Kansas Silent Reading Test. (See Table V for individual scores.) (Averages of each grade indicated by the arrows.)

are based on data which are not quite comparable and so can not be directly contrasted. Plate XXVI shows that the officers

as a class were superior to the enlisted men in intelligence. This fact may be expressed also as follows:

2.4% of the enlisted men were superior to 75% of the officers
6.4% of the enlisted men were superior to 50% of the officers
12.2% of the enlisted men were superior to 25% of the officers

Intelligence is not the only qualification needed by officers. Some of those with low intelligence scores were superior in leadership and experience. In the same way some of the enlisted men who were very superior in intelligence had very poor phy-

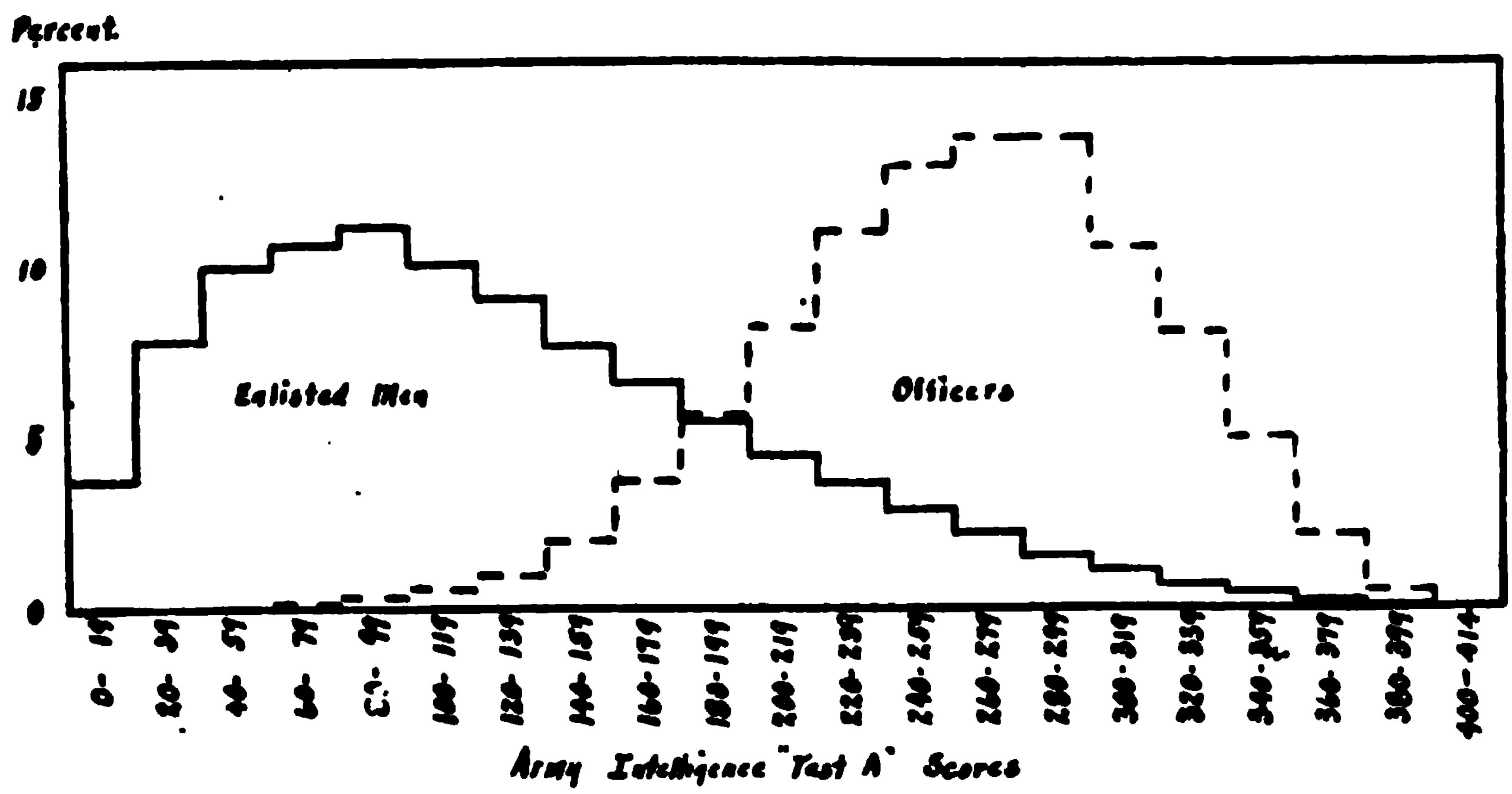


PLATE XXVI.—Showing the distribution of scores obtained by enlisted men and officers in psychological intelligence test (Test A). Based on scores of 128,747 "literate" men and 8,096 white officers. Undoubtedly many enlisted men too illiterate to take the test were included here.

sique and appearance or were lacking in education or leadership, etc. From the standpoint of the psychologists and personnel officers the problem of selection of men for officers' training camps was to find the superior enlisted men—superior both in intelligence and other necessary qualifications.

The sharp drop at the extreme left of the enlisted men's distribution curve proves conclusively that many enlisted men were not measured here who belonged to the group of enlisted men. This was true. Twenty-five per cent. of men were eliminated by the draft boards as below standard physically, mentally or morally. And the worst illiterates were not given the test.

Illiterates and those making a poor score in this test were given a test not involving reading.

Fundamental Causes of Individual Differences

Individual differences are to be thought of as the resultant of many more or less independent factors, each of which vary considerably. These factors may be grouped under the three headings—environment, heredity and training. In the case of heredity, we may look upon a human being as made up of many factors handed down to him from his parents through the two germ cells. These factors are more or less independent. According to the combination which results from all these factors we have any particular human being. As illustrated by the experiment in throwing dice, although there may be many combinations of factors with their individual variations there results (1) a much smaller number of distinct individualities and (2) the great majority of such individualities are much alike with only relatively few cases of marked variation from the average.

At the present time science has ascertained in only a few cases what the factors are which affect human beings so as to make them different. And even there this has been done only to a limited degree. One example may be mentioned simply to make this matter clearer. In the throat or neck are some small glands known as the *thyroid* glands. They secrete into the blood a substance which is "characterized by containing a large amount of iodin (9.3% of the dry weight)." This chemical, apparently, exercises in the tissues "a regulating action of an important or indeed essential character." Removal or atrophy of the thyroids results in a condition of chronic malnutrition; "in the young it is responsible for arrested growth and deficient development designated as cretinism, and in the adult the same cause gives rise to the peculiar disease of myxedema, characterized by distressing mental deterioration, an edematous (dropsy of the subcutaneous cellular tissue) condition of the skin, loss of hair, etc." On the other hand, enlargement of the thyroid glands "forms an essential factor of the disease exophthalmic goitre." "The salient feature of exophthalmic goitre is a lowered threshold to all stimuli." "The organism responds at such times to the

prick of a pin, a hint of danger, or the slightest infection, by a transformation of energy many times greater than would follow the same stimulation in the normal organism." Patients suffering from cretinism are now fed this iodin chemical, whereas patients suffering from exophthalmic goitre are operated on so as

TABLE VII.—SHOWING THE PERCENTAGE OF 4TH AND 8TH GRADE CHILDREN WHO (*a*) ATTEMPTED AND (*b*) SOLVED FROM 0 TO 20 PROBLEMS

Per cent. of pupils who *attempted* to do a given number of problems		Per cent. of pupils who *solved correctly* a given number of problems	
4th Grade	8th Grade	4th Grade	8th Grade
20 Probs.— 0%	20 Probs.— 5%	20 Probs.— 0%	20 Probs.— 2%
19 Probs.— 0	19 Probs.— 2	19 Probs.— 0	19 Probs.— 1
18 Probs.— 0	18 Probs.— 2	18 Probs.— 0	18 Probs.— 1
17 Probs.— 0	17 Probs.— 3	17 Probs.— 0	17 Probs.— 1
16 Probs.— 1	16 Probs.— 4	16 Probs.— 0	16 Probs.— 2
15 Probs.— 1	15 Probs.— 6	15 Probs.— 0	15 Probs.— 2
14 Probs.— 1	14 Probs.— 7	14 Probs.— 0	14 Probs.— 3
13 Probs.— 1	13 Probs.— 8	13 Probs.— 1	13 Probs.— 4
12 Probs.— 1	12 Probs.— 9	12 Probs.— 1	12 Probs.— 5
11 Probs.— 2	11 Probs.—11	11 Probs.— 1	11 Probs.— 7
10 Probs.— 4	10 Probs.—11	10 Probs.— 1	10 Probs.— 8
9 Probs.— 5	9 Probs.—10	9 Probs.— 2	9 Probs.— 8
8 Probs.—12	8 Probs.—10	8 Probs.— 3	8 Probs.—10
7 Probs.—14	7 Probs.— 6	7 Probs.— 6	7 Probs.—10
6 Probs.—21	6 Probs.— 4	6 Probs.— 9	6 Probs.— 0
5 Probs.—14	5 Probs.— 1	5 Probs.—12	5 Probs.— 9
4 Probs.—13	4 Probs.— 1	4 Probs.—14	4 Probs.— 7
3 Probs.— 6	3 Probs.— 0	3 Probs.—14	3 Probs.— 6
2 Probs.— 3	2 Probs.— 0	2 Probs.—13	2 Probs.— 3
1 Probs.— 1	1 Probs.— 0	1 Probs.—13	1 Probs.— 1
0 Probs.— 0	0 Probs.— 0	0 Probs.—10	0 Probs.— 1
Aver. 6.44	11.65	3.81	8.41

to reduce the amount of this chemical given off by the thyroid glands. We see here a single factor in the entire organism—the production of an iodine chemical—which when only slightly produced results in cretinism (deficient physical and mental

development), when normally produced results in normal behavior, and when excessively produced results in goitre accompanied by a chronic state of great excitability.[1]

The Overlapping of Distributions of Ability in Different School Grades

The scores of children in the Kansas Silent Reading Test for the various school grades overlap very greatly (see Plate XXV). Because such overlapping is one of the most important conceptions in educational theory today, it will repay us to consider

[1] Quotations are from W. H. Howell, *Physiology*, 1907, pp. 794–797 and G. W. Crile, *Man—An Adaptive Mechanism*, 1916, pp. 140–143 and 192–197.

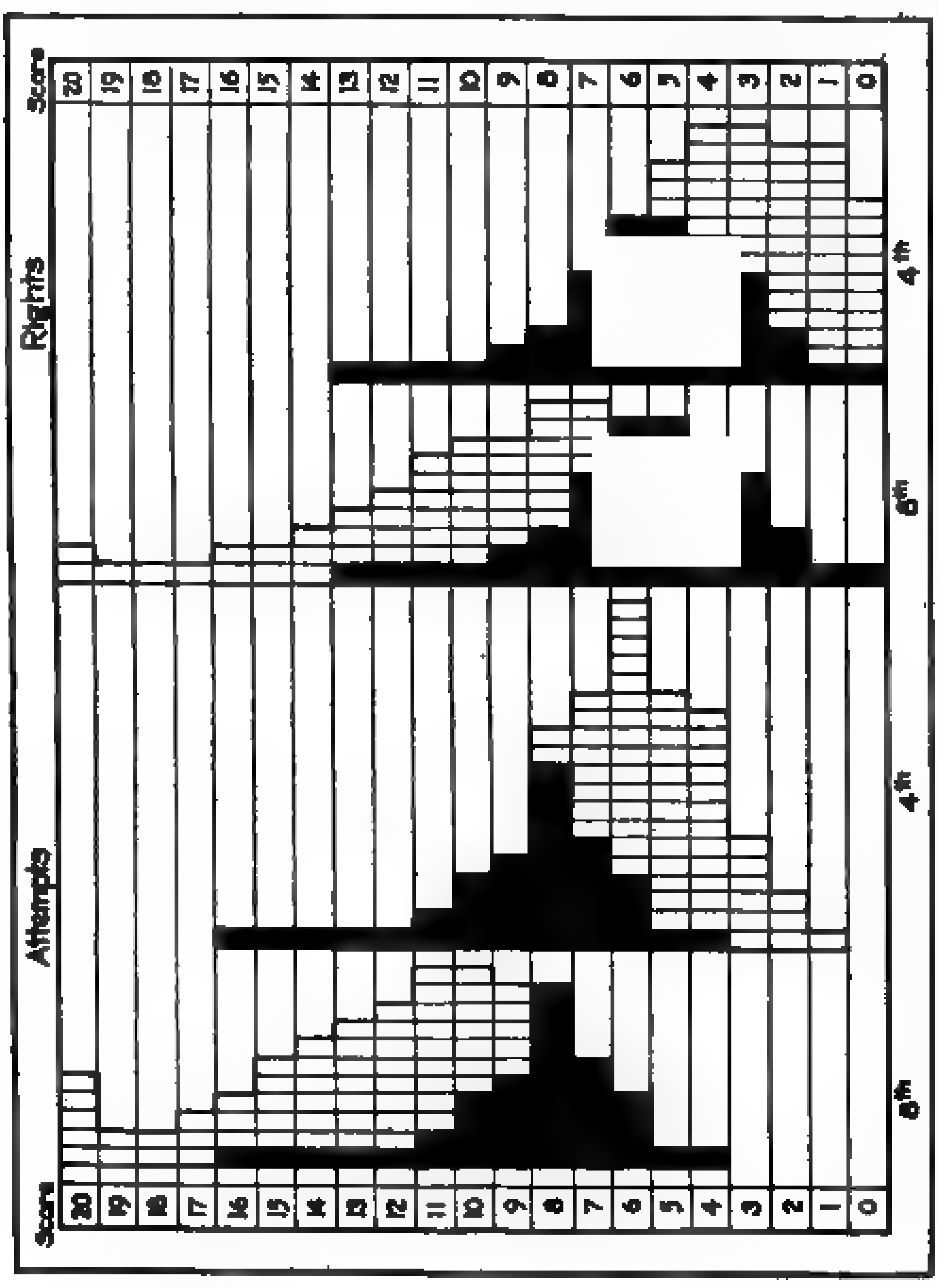


Plate XXVII.—Showing the percentage of 4th and 8th Grade children who (*a*) attempted and (*b*) got right from 0 to 20 problems in eight minutes. (Each small oblong represents one child in a class of one hundred. The black oblongs represent children in the 4th Grade who could be interchanged with corresponding children in the 8th Grade without affecting the averages or A. D.'s of either grade. From S. A. Courtis, Educational Diagnosis, *Second Indiana Educational Conference*, 1915, *p.* 154.

two other examples of it here. The Courtis Arithmetic Tests are employed to find out how rapidly and accurately pupils can do certain of the fundamental processes. For example, one of the problems in the column addition test is made up of the following numbers:—837, 882, 959, 603, 118, 781, 756, 222, 525.

Courtis[1] measures the *speed* of work by recording the number of problems "attempted" and the *accuracy* of the work by recording the number of problems which were "right" or correct. The four columns in Table VII show what per cent. of the two grades "attempted," or got "right," any specific number of problems ranging from 20 to 0. For example, the table shows that 0% of the 4th Grade attempted 20 problems while 5% of the 8th Grade attempted that number, and it shows that naturally 0% of the 4th Grade got 20 problems right, while 2% of the 8th Grade did solve that number correctly. It shows further that 1% of the 4th Grade attempted 12 problems as against 9% of the 8th Grade, and that 1% of the 4th Grade got 12 problems right, as against 5% in the 8th Grade. If we want to know just how many children attempted or solved correctly 12 or more problems in the two grades we must add up all the percentages in the table for 12 problems and better. This gives us the following: 5% of the 4th Grade attempted 12 or more problems as against 46% of the 8th Grade and 2% of the 4th Grade got right 12 or more problems as against 21% of the 8th Grade. All of this is shown diagrammatically in Plate XXVII.

The averages of the 4th and 8th Grades are given at the bottom of the table. The 8th Grade has done just about twice as well as the 4th Grade on the basis of these figures. In terms of such figures one would expect that *all* 8th Grade children would be superior to *all* 4th Grade children for the former averages 8.4 problems correct to 3.8 problems for the latter. But a study of the table and particularly the plate shows that this is false. Fifty-one of the children from the 8th Grade could be put in the 4th Grade and a corresponding number from the 4th Grade be put in the 8th Grade and the averages of the two grades for accuracy would not be affected at all. When we give our 8th Grade children a diploma, graduating them into the High School, we feel that the diploma means that they are up to 8th Grade

[1] S. A. Courtis, Educational Diagnosis, *Second Indiana Educational Conference*, 1915, p. 154.

standards and far superior to 7th, or 6th, or 5th, or certainly 4th Grade standards. But apparently many in the class are not. For here in this perfectly typical illustration based on about 11,000 children, 38 in every hundred 8th Grade children are no different from 38 other children in the 4th Grade as regards their speed of adding and 51 in every hundred 8th Grade children are no different from 51 other 4th Grade children as regards their ability to add correctly columns of figures.

The A. D.'s for the data in Table VII concerning the ability of children in the 4th and 8th Grades to add columns of figures are:—

Average number of problems attempted in 4th Grade.	6.44	A.D. 1.94
Average number of problems attempted in 8th Grade.	11.65	A.D. 2.69
Average number of problems correctly solved in 4th Grade..	3.81	A.D. 2.19
Average number of problems correctly solved in 8th Grade..	8.41	A.D. 3.09

As pointed out in Lesson 21 the size of these A. D.'s immediately warns us against supposing that all the children are equal to the average for their grade. They also confirm again the point made in Lesson 23 that the greater the training the more the individuals are different. Inspection of the surfaces of distribution in Plate XXVII. as well as the size of these A. D.'s shows that the members of the 8th Grade differ more among themselves than do the members of the 4th Grade. This fact would be all the more clearly shown if the children who have dropped out of school between the 4th and 8th Grades, were present in this 8th Grade. For most of them would appear at the lower end of the surface of distribution.

A survey was made of English composition at Purdue University in September 1919, the freshmen being required to write a short composition. Results showed that 10 %, excluding foreign students, "have composition ability on the same level as the sixth grade in Detroit, Michigan." Work typical of this poorest 10% was as follows:—

"One night last winter. I got into my mother's cubord, and got a whole mince pie and ate it, just before going to bed. And of all the bad dreams I had the worst.

"I drempt I was taken to China and roasted alive. Next the India tans tortured me, then I was taken to Africa and left in

the jungles and again I was in a ward with the small pox and when I was about to die I awoke with a sick headache."

"There were 111 compositions of about this quality . . . This may be taken as indicating that 10% of the entering class, either on account of innate mental deficiency or inadequate training, have not mastered the elementary mechanics, the simple conventional technique of expressing their thoughts in written form. These students are evidently not prepared to do high school work in English, to say nothing of attempting freshman work in college . . . .. The assumption that all freshmen are prepared to do the same type of English work, and the fairly common practice of grouping, instructing, and grading on this basis, seems to be without any pedagogical justification."[1]

This matter of how students differ among themselves is a very important problem affecting our whole educational system in a very profound way. When we realize that 51% of 8th Grade children add columns of figures no more accurately than a corresponding percentage of 4th Grade children and that 10% of college freshmen write compositions no better than average sixth grade children we must realize that something is wrong with our school system. All of our methods of study, all of our methods for supervision, and all of our administration schemes should be subjected to careful scrutiny in order to see if any of them are the cause for such astounding comparisons. Possibly, radical changes might produce a more uniform proficiency in the grades. Possibly the graded system itself is at fault. Possibly the differences discussed here are inherent in children themselves, so that very little or nothing can be done to rectify the matter. If that is the case, then, changes possibly should be made so that all diplomas might have a more definite meaning than they now appear to possess.

[1] G. C. Brandenburg, The Quality of Freshman Composition, *School and Society*, Dec. 17, 1921.

LESSON 26

HOW SHOULD STUDENTS BE GRADED?

One of the most perplexing problems in education today is that of grading students. Until very recently the subject was ignored, for it was taken for granted that if a person was capable of teaching his class he was capable of grading the students in that class. Even today, the vast majority of teachers consider it their inalienable right to grade as they please and strenuously resent any interference with their methods. Recent studies made on this subject show, however, that teachers differ very widely in the way they grade their students. In fact, the variation is so great that it is perfectly apparent that all cannot be grading their students fairly. And when "honors" are based on the grades of different instructors the injustice of the present system is clearly apparent. A friend of the writer deliberately restricted his work as far as possible to the three departments of Latin, German, and History in a great university, because he realized that it was easy to make high grades there and he was determined to win Phi Beta Kappa. These three departments granted "A's" to 30% of their students, while many other departments granted "A's" to less than 5% of their students. He made his Phi Beta Kappa key but at the expense of a broad, well-rounded college training. If he had taken courses from many departments he would have stood certainly less than half the chance of getting high grades and probably not more than one-third the chance.

Below are given (See Table VIII) the grades which an instructor awarded a class in history. They are the grades from three examinations, and the final grade for the semester is to be made up from them, each of the three to count one-third of the final grade. (The grades were obtained by the instructor assigning definite values to each question or part of a question, scoring the student in terms of each question, and finally adding up all these separate scores. The grades given here have been modified

somewhat by the writer but they approximate in a general way the grades actually given by this instructor.)

Plot surfaces of distribution for the three sets of grades listed below.

TABLE VIII.—THE GRADES GIVEN BY AN INSTRUCTOR IN THREE EXAMINATIONS. WHAT SHOULD BE THE FINAL GRADE OF EACH STUDENT?

STUDENTS	FIRST EXAM.	SEC. EXAM.	THIRD EXAM.
1	60	100	70
2	55	90	55
3	50	80	80
4	45	95	55
5	45	85	70
6	40	95	50
7	40	80	50
8	35	70	65
9	35	85	45
10	30	75	60
11	30	80	50
12	30	90	75
13	25	95	30
14	25	90	60
15	20	90	55
16	20	85	55
17	20	80	35
18	15	100	50
19	15	65	40
20	10	80	45
21	10	85	35
22	5	85	45
23	5	60	30
24	0	75	25

Answer the following questions:—

1. Who is responsible for the low grades in the first examination and the high grades in the second examination? Do the grades mean that the students loafed before the first examination and studied hard before the second? Or do they mean that the first examination was too hard or too long and the second too easy or too short? Or do they mean that the course of study was poorly organized at the beginning and the teaching was poor at the start and after the poor showing in the first examination the teacher "woke up" and "got busy" and did good teaching?

Who, then, is primarily responsible for the grades in the first

examination ranging from 60 to 0 and in the second examination from 100 to 60?

2. Which grade represents the greater ability, 60 given in the first examination or 80 given in the second? 60 is 20% inferior to 80, of course. But, on the other hand, only one student received 60 in the first examination and none received a higher rating, whereas in the second examination 5 students received 80 and 14 more received higher grades than 80.

3. If we arrange the students in order of merit according to their grades in the examinations, we find that

the best student got 60, 100, and 80, respectively,
the 12th student got 30, 85 and 50, respectively, and
the poorest student got 0, 60 and 25, respectively.

Are 60, 100 and 80 equal then? Or 30, 85 and 50? Or 0, 60 and 25?

4. In grading examination papers should we grade in terms of the "ideal" paper, the best paper, the paper of an average student, the poorest paper or "zero" knowledge? With which one of these standards is the teacher most likely to be familiar? Which one is most likely to fluctuate from year to year?

5. What final grades would you give these 24 students on the basis of the three examinations? Plot the surface of distribution for the grades you assign.

6. Are your final grades fair to the students? To the instructor? To students in other sections of this same history course? To other instructors? To the institution as a whole? Explain.

Hand in your report at the next class-hour.

LESSON 27

METHODS OF GRADING STUDENTS

The matter of grading students in a class is a subject that is intimately connected with the subject of individual differences. It is introduced here as an illustration of how this subject is related in still another way to educational theory and practice.

Systems of Marking Students

Grading on Percentage Basis with Prescribed Passing Mark.—One of the two most universally used systems of grading students is to give students grades ranging from 0 to 100, with some grade as 50, or 60, or 75, or even 80, as a passing mark.

The theory underlying the granting of percentages is that the student is *graded in terms of absolute proficiency*. If he gets 90 in an examination in arithmetic or spelling, he has done 90% of the examination correctly. The system works fairly well here. But it falls down completely in such subjects as English composition, or history or geography, etc. For who knows what is absolute proficiency in composition work for 5th grade children? How does such a standard differ from that of the 4th grade, or that of the 6th grade? Actually in ordinary practice the grades represent at best only a certain percentage of what the teacher considers the class can do. It is based on two very variable things—the teacher's estimate of what the class can do, and second—the class itself. If the class is better than usual, the teacher's grades stand for better work than usual; if the class is poorer than usual, the teacher's grades represent poorer work than usual. Despite the best efforts of any teacher his grades are not standardized on the basis of a fixed absolute standard but vary with the calibre of his pupils. It is impossible under such conditions to ever expect that a "85" will represent a definite standard of work in a particular course. The 85 will vary from year to year with the same teacher, and it will vary with every two teachers, depending on those teacher's estimates of what a class can do.

(All of these statements have been substantiated in every investigation on this subject and are no longer open to argument.)

The Jury System of Grading.—In some cases grades are awarded by a committee or jury instead of by one instructor. This system eliminates a good deal of the personal bias of a particular instructor and undoubtedly does tend to standardize the grades. It is especially applicable in grading performance in art, architecture, music, and the like. The system is also used in this way. All the instructors of Freshman mathematics, as a committee, draw up the examination questions. Later each instructor grades one question in all the papers of all the sections. Here the examination questions are more carefully considered than is usually the case, and each question is marked for all papers in as nearly the same manner as it is humanly possible to provide. But the jury system does not eliminate marked variations in grading between juries.

Grading on Basis of Five Groups.—The other most universally used system of grading students is to give the students grades in terms of about five letters or numbers, such as A, B, C, D, and F; or E, S, M, I, and F; or again 1, 2, 3, 4, and 5. The A, E, or 1 is given to the best students; the B, S, or 2, to the next best group, etc. The F or 5 is considered as failure. Sometimes the fourth grade, D, I, or 4 is "not passing" and sometimes it is considered as "conditioned" requiring another examination. At still other institutions D is a passing grade but entitles the student to but 80% credit, so that in a 5-hour course the student with a D will receive but 4 hours credit.

It is because of insurmountable difficulties pointed out above in connection with the percentage system of marking that this system of grading students with five letters has arisen. The whole scheme of grading students on the basis of an absolute standard of perfection is thrown away, or almost thrown away.[1] The teacher then roughly divides the class into five groups, the excellent students, the good, the fair, the inferior, and the failures. More or less of the old scheme survives in the case of deciding

[1] Of course, in those cases where a teacher marks a student by these five letters but always translates the letter into a numerical figure so that A equals 100 to 95; B, 95 to 85; etc., he is practically following the first scheme and not the second. When the second scheme is used properly there are no numerical values attached to the letters.

just what will constitute a passing standard as distinguished from a failure. The essential thing, however, is the division of the class into five groups in terms of their general ability and performance in the particular class.

Anyone familiar with the laws underlying individual differences immediately realizes that these five groups should not contain an equal number of students;—that the largest number of students should be in the middle group, and that relatively few should be in the two extreme groups, the excellent students and the failures. But the study of how teachers grade students shows clearly that teachers differ enormously as to how they distribute their grades under this scheme. In Table IX is shown the distribution of grades in seven courses in the University of Missouri prior to 1908. It is clear from this table, and it represents conditions in every institution of that time and most institutions today, that a student could quite easily win "honors," or a scholarship, or make Phi Beta Kappa by electing Philosophy, Economics, etc., but would have an extremely small chance of obtaining these honors if he grouped in Chemistry. Yet an "A" counted equally toward these honors whether obtained in Philosophy or Chemistry III. In the same way a poor student would have little trouble in passing Philosophy but would stand a good chance of being "flunked" in English II or Chemistry III.

TABLE IX.—SHOWING THE RELATIVE FREQUENCY OF FOUR GRADES A, B, C, AND F AS FOUND BY MAX MEYER IN THE UNIVERSITY OF MISSOURI IN 1907[1]

Course	Distribution of Grades				Total No. of Students Considered
	A	B	C	F	
Philosophy	55	33	10	2	623
Economics	39	37	19	5	161
German II	26	38	25	11	941
Education	18	38	35	9	266
Mechanics	18	26	42	14	495
English II	9	28	35	28	1098
Chemistry III	1	11	60	28	1903

[1] Max Meyer, The Grading of Students, *Science*, Aug. 21, 1908, p. 3.

The problem educators are now facing in regard to grading students is how to make an "A" or "F" mean the same thing whether given by Prof. Smith or Prof. Brown, whether given in Philosophy or Chemistry, whether given in 1915 or 1917.

An important step toward obtaining equitable grading has been to apply the conception of our normal surface of distribution to the problem. Any group of students (barring exceptional cases considered below) will divide themselves up into inferior, average, and superior students and these three groups will approximate 25%, 50% and 25% in size, respectively. They will do so if the method of grading them is fair. If, however, the examination is too easy or too difficult there will appear not a normal distribution but one in which there are too many superior or too many inferior students, respectively. If in two classes of 100 students, Prof. Smith and Prof. Brown require a *fair* amount of work, then 25% of the students will do superior work, 50% average work and 25% inferior work. If Prof. Smith requires too much and Prof. Brown too little, then it may appear that the former has 40% inferior and 10% superior students whereas the latter has 10% inferior and 40% superior students. If we require each professor to grade 25% of his students superior, 50% average and 25% inferior, then we recognize (1) that one class of students taken as a whole is about equal to any other class and (2) that students are graded in terms of what an average student will do and not in terms of a variable standard of what is required by different instructors. In such a case we know that a "superior" student for Prof. Smith has actually done better work than ¾ of the students in his class and that a "superior" student for Prof. Brown has likewise surpassed ¾ of his class. *A given grade is not then a grade in terms of any absolute standard of perfection but is a grade in terms of what average students do.*

With such a requirement the irregular grading shown in Table IX was eliminated to a large extent at the University of Missouri. The average of all the grades for the undergraduate courses became in 1911, 23.7% superior, 49.9% average, and 26.4 inferior. Nineteen of the instructors distributed their grades as shown in Table X. Comparison of the individual instructor's gradings in this table with those in Table IX shows an enormous improvement in the matter of uniform grading on the part of the faculty.

An "E" now means nearly the same high grade of scholarship whether given by one instructor or another. The gradings in Table X are, however, still too irregular as respecting Grades "I" and "F" to be entirely satisfactory.

The Missouri System of Grading.—As can be seen from Table X, the Missouri system of grading students provides first of all

TABLE XI.—SHOWING THE RELATIVE FREQUENCY OF THE FIVE GRADES E, S, M, I, AND F, AS USED BY VARIOUS INSTRUCTORS IN THE UNIVERSITY OF MISSOURI IN 1911[1]

Instructors	% E	% S	% M	% I	% F
A	7	29	51	8	5
B	5	23	52	15	5
C	3	21	51	21	4
D	7	21	56	8	8
E	6	15	60	13	6
F	1	22	55	17	5
G	2	17	64	11	6
H	3	21	52	18	6
I	3	24	46	21	6
J	3	20	51	20	6
K	3	20	53	16	8
L	3	23	47	17	10
M	2	19	55	14	10
N	4	19	45	23	9
O	5	20	43	21	11
P	7	21	47	9	16
Q	3	13	52	19	13
R	5	11	43	29	12
S	3	15	47	20	15
Average.......	3.9	19.7	51.0	16.8	8.5
	23.6		51.0	25.3	

for the students being divided into three groups—superior, average, and inferior—so that the first group comprises the best 25% of the students, the second group the middle 50%, and the third the remainder. The superior and inferior are further

[1] Based on the "Report of the Committee on Statistics on the Grading of the Semester," Closing Feb., 1911.

divided so that in effect there are five grades of E (excellent), S (superior), M (medium), I (inferior), and F (failure). As illustrated in Plate XXVIII the surface of distribution is so divided that the difference in ability represented by Grades E and S is equal to the difference between S and M, or M and I, or I

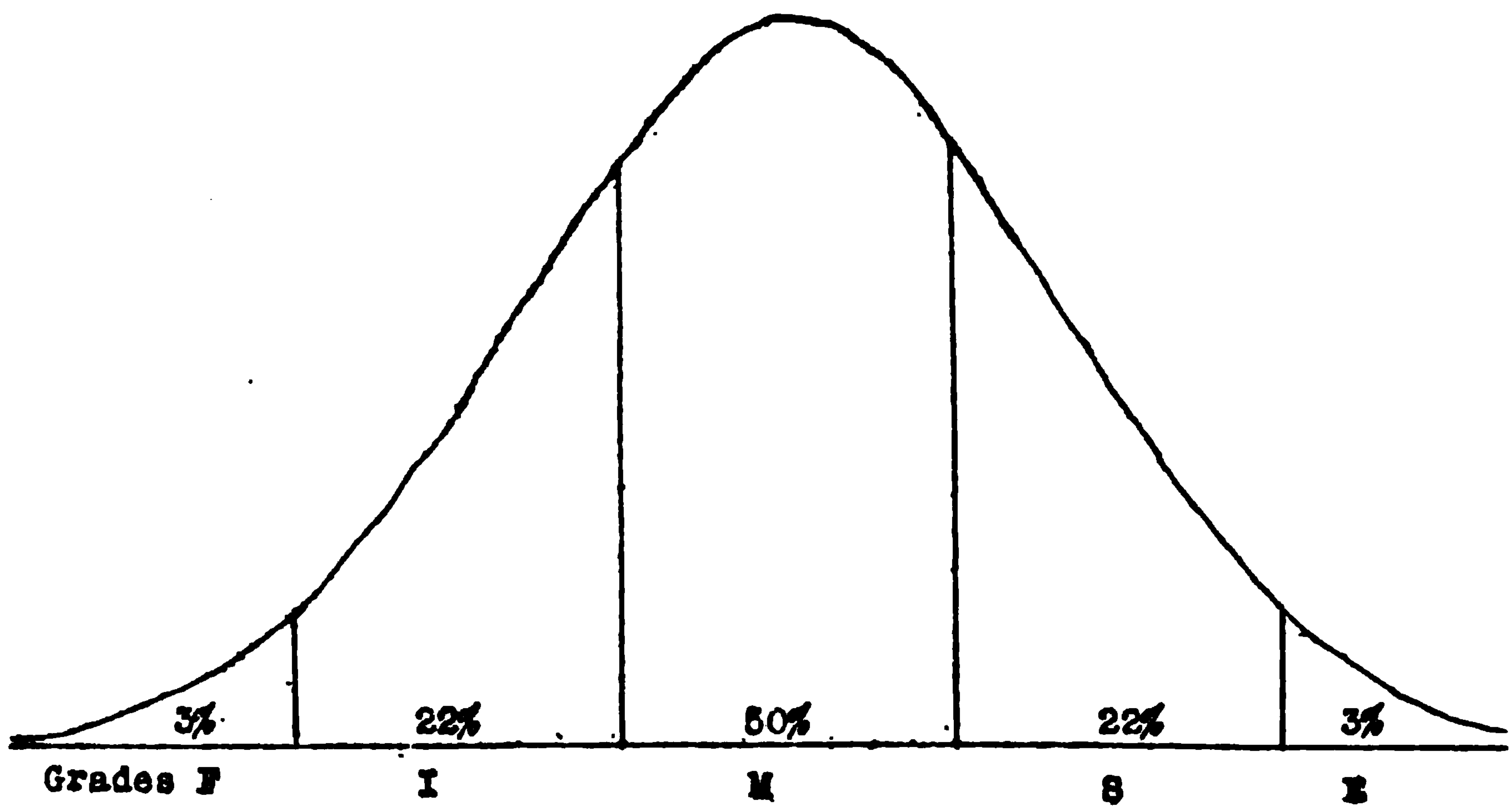


PLATE XXVIII.—A normal surface of distribution divided up into five groups showing five grades of scholarship. At the University of Missouri these five grades are called F (failure), I (inferior), M (medium), S (superior), E (excellent).

and F. The standard which all instructors are expected to reach in their grading is then that 50% of the students shall receive an M, 22% an S, 22% an I, 3% an E, and 3% an F.

One objection to this scheme will immediately occur to some readers. Maybe half the class has actually failed and you have given most of them a C or D. Will that method of marking be fair? Yes, certainly; for if half the class fails, who is to blame? Undoubtedly, in practically every case, no one but the teacher. The examination was too difficult, or too long, or because of poor discipline the students had not studied. This system throws the blame for poor work in the class on the person who deserves the blame—the teacher. Of course, sometimes a group of students will not work, then the only final resort is to "flunk" them. But such cases are rare as compared with those where the trouble lies in the main with the instructor.

Here are the faculty rules of 1917 at George Peabody College for Teachers on this subject. They make plain that the above

system applies directly to large classes and only indirectly to small classes, and possibly not at all to exceptional classes, such as in graduate courses.

"It is fair to assume that the average student in any undergraduate course is equal in ability to the average student in any other undergraduate course. Consequently it is fair to expect that all members of the faculty will in the long run (when they have marked 500 students, say) give approximately the same per cent. of students each of the five grades.

"It is also fair to assume that the calibre of classes does vary, and that this is particularly true in the case of very small classes. Consequently it is fair to expect that the members of the faculty will vary considerably in the way they mark the members of particular classes.

"We expect then in the long run that the members of the faculty will all use the same standards. We also expect, on the other hand, that there will be noticeable variation in the way individual classes will be marked. In the light of these assumptions, the following rules are laid down:

"1. The quality of the student's work in a course shall be reported to the registrar by use of the following grades: A, B, C, D, and F.

"2. The grade of 'C' is designed to represent the performance of the middle 50% of the class. The grades of 'B' and 'D' represent work that is superior and inferior, respectively, to that of the middle group. The grade of 'A' is received for markedly superior work, while the grade of 'F' is designed for those who have failed and shall receive no credit for their work. Students receiving the grade of 'D' will receive but 80% of the full credit attached to the course, i. e., in a five-hour course such a student will receive but four hours credit.

"3. It is recognized that the more advanced the student the more selected is the class with which he will be grouped and the system of marking will vary proportionately.

"4. Experience has shown that in the long run the instructor will give approximately 3% of his students an 'A,' 22% of his students a 'B,' 50% a 'C,' 22% a 'D,' and 3% an 'F'."

Such a uniformity of grades from the members of a faculty is highly desirable and is to be expected so long as it can be assumed that the calibre of students in one class is equivalent to those in another class. If an instructor gives proportionately more low or high grades in his classes than this ideal, he declares in so doing that his students are poorer or better than the students in other classes. This is, of course, in many cases an actual fact, and when so, an instructor should mark accordingly. But in the ordinary course of events one class is pretty nearly equivalent to another class as far as ability of the students composing it is concerned.

Varying the Amount of Credit with the Grade Given.—The University of Missouri further provides that students shall obtain varying amounts of credit for their work according as they obtain high or low grades. At the present time in a one hour course, a student obtaining an E earns 1.2 hours credit, a student obtaining an S earns 1.1 hours credit, a student obtaining an M earns 1.0 hour credit, a student obtaining an I earns 0.9 hour credit, and a student obtaining an F earns 0 credit.

The Carnegie Institute of Technology System of Grading.—Two differences, one significant and one slight, are to be found between the Carnegie Institute of Technology system of grading and that of the University of Missouri. In the former, grades are recognized as of two sorts, those for passing work and those for work below passing. No attempt is made to legislate as to what per cent. of students shall pass in a particular course. That is left entirely to the instructor, or his department, for in many departments the jury system of marking is employed. This is the significant difference referred to above. It rests upon the assumption that an instructor can arrange passing students in order from best to poorest and he can arrange failing students similarly in order of merit, but he can not view passing and failing students as belonging to the same group. Professor Meyer, who has been responsible for the Missouri System and for much of the advance in thinking on this whole subject, writes that he has become "more and more convinced that in determining the final grade the group grade should be applied only after the failures have been selected."

The insignificant difference pertains to the number of grades, and their distribution. At Carnegie Institute of Technology, A and B are given to the best third of passing students, C to the middle third, and D and E to the lowest third of passing students. Distribution based on thirds was agreed upon because it fitted the distribution of all grades given at the time the system was adopted. In addition to the five passing grades, I is given to students whose work has been satisfactory except that part is not yet finished; F to students who are privileged to take a reexamination, and R to students who must repeat the course.

Points for Quality.—Students are required not only to complete a certain quantity of work, but also to attain a certain standard

of quality. The passing grades carry the following points of quality:—A, 4 points; B, 3 points; C, 2 points; D, 1 point; and E, 0 points. A student may pass in all his work but receive too few quality points to meet the requirements and so be dropped.

Present Tendencies in Grading

Among colleges and universities the tendency is away from the percentage system to the group system and to a less extent toward the Missouri system, which has been adopted more or less entirely in a number of institutions.

Among secondary schools, today, 30% employ percentage systems and 65% the group system. Of those using the group system, 44% have three grades above passing, 52% have four grades, and 4% have five grades. The National Conference Committee on Standards of Colleges and Secondary Colleges recommends that, "if a group system is used, the letters A, B, C, or A, B, C, D be employed to indicate passing grades, and that E or F, or both E and F, be reserved for failure. The committee calls attention to the fact that the majority of colleges use four groups above passing, and that the tendency in schools appears to be in that direction.

"The committee recommends that schools using a percentage system follow what appears to be the most common practice, of using 60 as the passing grade.[1]

Discussion of the Problem Assigned in Lesson 26

With these general considerations before us let us turn now and consider the problem which was assigned in Lesson 26.

The Surfaces of Distribution; What They Show.—The grades from the three examinations given in Lesson 26 are plotted in surfaces of distribution in Plate XXIX. The three surfaces approximate the normal surface of distribution. The first one is long drawn out: The effect obtained when the examination is too difficult. The low grades show the same fact. The second distribution is skewed—most of the grades are bunched at the upper end. This is characteristic of too easy an examination or one where nearly all could answer the questions in the alloted time. If the time had been cut in half the distribution would have resembled that of the third examination.

[1] Report in *School and Society*, March 1, 1918, by Headmaster Ferrand.

If we followed the old scheme of marking where, say, 60 was the passing mark, we would, in the first examination, if we were true to our standards and had the requisite courage, fail all but one in the class. In the second examination we would pass every one, and in the third we would fail 17, or 71% of the class. Averaging the three sets of grades we obtain the results given at the bottom of Plate XXIX. These grades would necessitate our failing 14 members of the class, or 58%. If the passing grade were 75 all but one of the class would fail. If it were 50 then 7 would fail, or 29%.

This example is an extreme one, but is based on an actual case. It is, however, useful here as it points out in an exaggerated form the real situation that confronts the majority of instructors in their marking of students' papers. The grades a class actually receives, considering the class as a whole, are dependent on the instructor and him alone. If the examination is difficult the class as a whole gets low grades, if the examination is easy the class as a whole gets high grades. Instructors who mark low are generally instructors who require much from their students, while instructors who mark high do not require enough. Of course, there are many exceptions to this rule. To set up a standard such as 60 or 75 as a passing mark is to postulate that the instructor is omniscient, that he knows exactly how easy or difficult to make an examination.

The best method of grading is to assume that the average student in one class is equal to the average student in another. This assumption is correct remarkably often, as determined by actual investigations. When this is done, *if one is using the Missouri system of grading*, the middle half of the class, regardless of whether they obtain 30, 85, or 50, are graded C. The upper fourth are graded A or B, and the lower fourth, D or F. Theoretically 3% should receive an A and an equal number an F. In actual practice, an instructor should feel free to give no A or F, or several, depending on the circumstances of the case. On the basis of Plate XXIX.

1 student would receive an A, or 4%
6 students would receive a B, or 25%
10 students would receive a C, or 42%
5 students would receive a D, or 21%
2 students would receive an F, or 8%

The A and F grades must depend on circumstances.

In this particular case Student 1 is so far ahead that he alone would be given an "A" unless the work of the class, including 1's work, was not very good. In the same way no grade of "F" might be given if the work of 23 and 24 was acceptable; or if the work was poor 19 might also be given an "F." But in the long

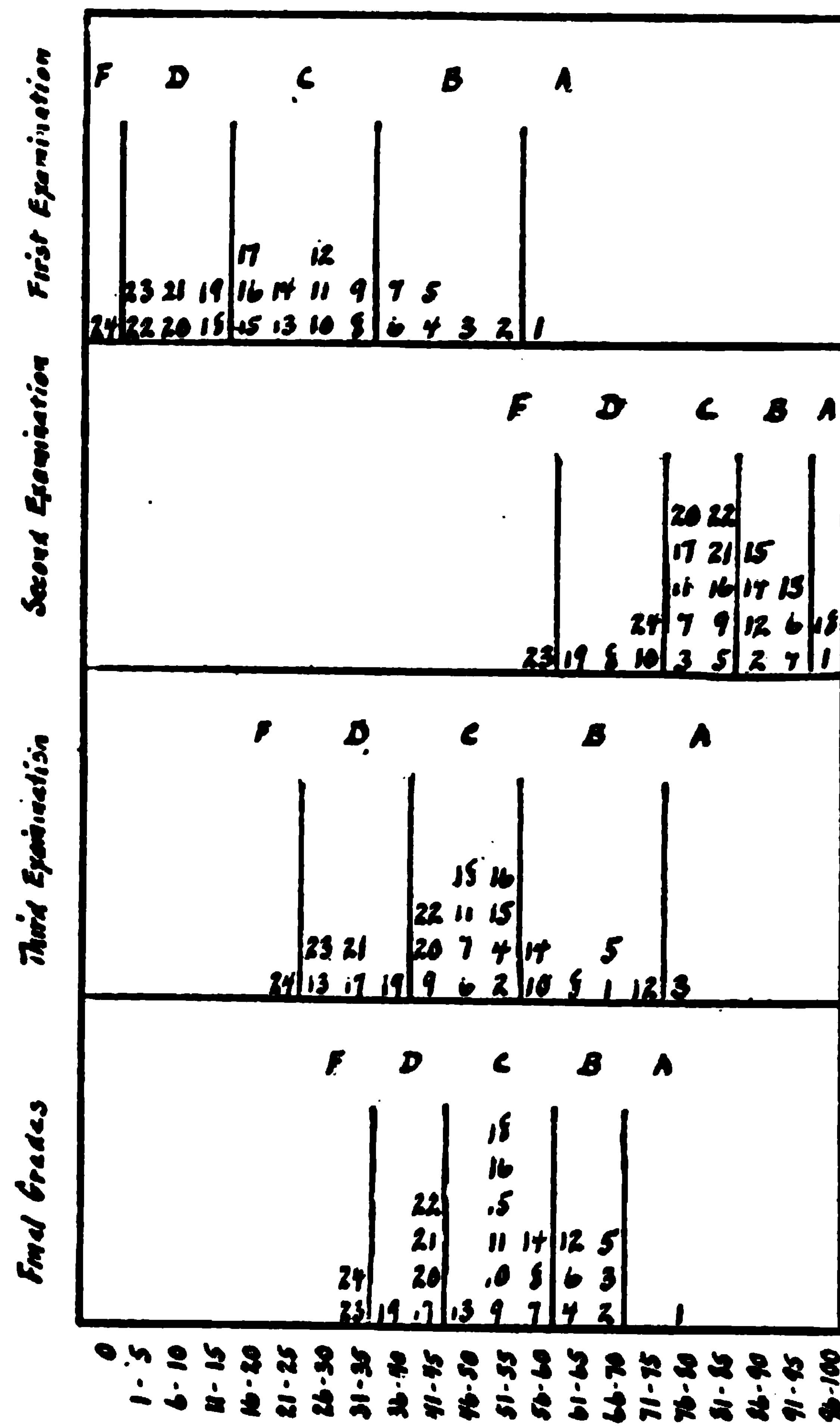


PLATE XXIX.—The examination grades given in Table IX and the computed final grades plotted in surfaces of distribution, together with their conversion into Grades A, B, C, D and F.

run, the instructor should give grades approximately as follows:—A—3%, B—22%, C—50%, D—22% and F—3%.

If one were using the Carnegie Institute of Technology system of grading, the merits of each individual student would be considered, starting possibly with the poorest, and it would be decided whether each had passed or failed. Those who had passed would then be divided into thirds, as described above.

How to Grade Papers

There are undoubtedly many good methods of grading a student's paper. Circumstances will determine whether one will read the whole paper through and grade it as a whole, or whether one will grade each part and then total the parts. The two give about the same result. Regardless of how the papers are individually scored, when that operation is done, one should convert the temporary grades into the grades A, B, C, D, and F. Divide the class into four fairly equal groups. Grade the first group A and B, the two middle groups C, and the fourth group D and F. If there are any exceptionally good or bad papers grade them A, or F, accordingly.

Some instructors find the easiest method is to read the paper through, judge its total value and place it in one of seven piles according to its merit. When all are finished the piles are readjusted if the first two do not contain approximately 25%, the next three 50% and the last two 25%. They are then graded, respectively, A, B, C+, C, C−, D and F. Practically nothing is gained by the subdivision of Group C into three sub-divisions, except to make the instructor feel he is doing a more accurate job.

How to Record Grades.—In Table XI are presented three methods of keeping a class-record. The first method consists in grading in terms of figures from 0 to 100, recording these figures and finally averaging them. This method has little justification. The manipulations of large figures takes too long a time, even when one has an adding machine at his disposal.

The second method consists of recording the letter grades. It is satisfactory, except when it comes to averaging up the records. With only three examinations to average there is little trouble, but if one has to average ten grades, how shall he do it? For example, how would you finally grade students who received (a) A, B, C, C, D, B, C, C, F, and B and (b) B, B, C, D, B, D, C, C, C,

and A? The easiest method of keeping one's record book and a method as reliable as any other is that shown as the third method in Table XI. The letters A, B, C, D, and F are represented

TABLE XI.—EXAMINATION GRADES, GIVEN IN TABLE VIII, AVERAGED BY THREE DIFFERENT METHODS

Student	First method					Second method				Third method				
	1st	2nd	3rd	Av.	By letters	1st	2nd	3rd	Av.	1st	2nd	3rd	Av.	By letters
1	60	100	70	77	A	A	A	B	A	4	4	3	3.7	A
2	55	90	55	67	B	B	B	C	B	3	3	2	2.7	B
3	50	80	80	70	B	B	C	A	B	3	2	4	3.0	B
4	45	95	55	65	B	B	B	C	B	3	3	2	2.7	B
5	45	85	70	67	B	B	C	B	B	3	2	3	2.7	B
6	40	95	50	62	B	B	B	C	B	3	3	2	2.7	B
7	40	80	50	57	C	B	C	C	C	3	2	2	2.3	C
8	35	70	65	57	C	C	D	B	C	2	1	3	2.0	C
9	35	85	45	55	C	C	C	C	C	2	2	2	2.0	C
10	30	75	60	55	C	C	D	B	C	2	1	3	2.0	C
11	30	80	50	53	C	C	C	C	C	2	2	2	2.0	C
12	30	90	75	65	B	C	B	B	B	2	3	3	2.7	B
13	25	95	30	50	C	C	B	D	C	2	3	1	2.0	C
14	25	90	60	58	C	C	B	B	B	2	3	3	2.7	B
15	20	90	55	53	C	C	B	C	C	2	3	2	2.3	C
16	20	85	55	53	C	C	C	C	C	2	2	2	2.0	C
17	20	80	35	45	D	C	C	D	D	2	2	1	1.7	D
18	15	100	50	55	C	D	A	C	C	1	4	2	2.3	C
19	15	65	40	40	D	D	D	D	D	1	1	1	1.0	D
20	10	80	45	45	D	D	C	C	D	1	2	2	1.7	D
21	10	85	35	43	D	D	C	D	D	1	2	1	1.3	D
22	5	85	45	45	D	D	C	C	D	1	2	2	1.7	D
23	5	60	30	32	F	D	F	D	F	1	0	1	0.7	F
24	0	75	75	33	F	F	D	F	F	0	1	0	0.3	F

in the record-book by the figures 4, 3, 2, 1, and 0, respectively. (Figures are easier to write than letters to begin with, and they can readily be averaged. Contrast the labor involved in averaging them with that of averaging the figures employed in the first method.) Averages between 0 and 0.5 would then be graded F; between 0.5 and 1.5, D; between 1.5 and 2.5, C;

between 2.5 and 3.5, B; and between 3.5 and 4, A. This scheme tends, however, to give too many C's and too few of the other grades. A better method is as follows: Before making out one's final grades, plot the average grades in the surface of distribution as shown in Plate XXX, and award the final grades according to their position on that surface.

A comparison of the final grades awarded in Plates XXIX and XXX shows that they are almost identical. The laborious attempt at great accuracy pursued in the first method of recording grades (see Table XI and Plate XXIX) gives practically the same results as those obtained by the easier third method (see

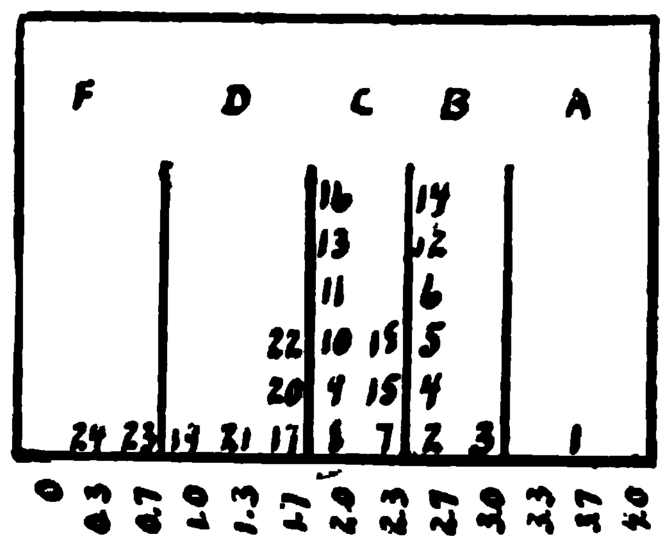


PLATE XXX.—The final grades, computed according to the third method in Table XII, plotted in a surface of distribution.

Table XI and Plate XXX). And in the case of Student 14, after all, which is the fairer grade for him, a "C" or a "B"?

A rather technical point ought to be known to teachers. In any system of averaging grades it is possible for a student who has never been graded best in any assignment to obtain the highest average grade, and likewise for a student who has just "scraped through" every assignment, to be graded lower on the average than one who has failed in many assignments. A student who has been consistently B or D (E representing failure) should not necessarily be graded A or E just because A students part of the time have also received low marks or E students part of the time have also received high grades.

CONCLUSION

We are graded in life not according to some ideal standard of perfection, but in comparison with our fellows, particularly our competitors. Edison is great, not because he approximates

perfection but because he is superior to other men. We have no standard of perfection as such. Our minister, or lawyer, or music teacher, or grocer is superior or inferior in comparison with other ministers, lawyers, music teachers, or grocers we know. The grading of students should be made frankly on the same basis, until such time as *definite standards* have been established and *precise methods* of ascertaining that a student has or has not attained the standard have been developed. At the present time such standards, or norms, have been set up in handwriting, spelling and a few other cases.

LESSON 28

COEFFICIENT OF CORRELATION

In Lesson 20 a preliminary study was made as to whether those who were best at the start were best at the end in such training as doing the mirror-drawing experiment. After we had arranged the ten individuals A to J (see Table III) with respect to their initial and final abilities we found it difficult to express just what the relationship between the two orders was. In this lesson we shall attempt a more satisfactory study of this point.

So far we have considered the average and the average deviation as measurements which help us in our study of individual differences. Still another measurement is needed:—the *coefficient of correlation.* This measurement is needed when we attempt to compare the order of superiority of a group of individuals at one time with their order obtained at another time. For example, in the results obtained from Lesson 20, just what is the relationship between the two orders? On the whole, we can see that those who ree best at the start are best at the end; still there are exceptions. And if, instead of B holding 1st and 4th positions, respectively, he held 1st and 10th positions (i. e., had a final score of 90), we would find it extremely difficult to state just how this change had really affected the entire relationship between the two sets of figures. Here are these two cases:—

Case I. (Based on actual data)				Case II (B's data altered)			
Initial	Ability	Final	Ability	Initial	Ability	Final	Ability
B	76	G	35	B	76	G	35
I	129	J	36	I	129	J	36
J	131	I	40	J	131	I	40
C	210	B	50	C	210	E	52
E	216	E	52	E	216	C	58
A	232	C	58	A	232	H	60
G	283	H	60	G	283	A	61
F	286	A	61	F	286	F	70
D	363	F	70	D	363	D	85
H	701	D	85	H	701	B	90

From a study of the two sets of relationships it is clear that there is a closer relationship in the first case than in the second. But it is impossible to estimate this difference by looking at the figures. We need some clear and definite method of expressing such relationships. This is exactly what the coefficient of correlation gives us. Below is an example fully worked out. Study it carefully so as to be able to obtain the coefficient of correlation in similar examples yourself. (Only advanced students in psychology or education are called upon to use correlation, but the term is used very freely in gatherings of educators today and should at least be comprehended by all.)

How to Obtain a Coefficient of Correlation

The several steps involved in obtaining a coefficient of correlation are as follows:—

1. Arrange your individuals in order of merit in the two cases to be studied. (If two or more individuals are tied, then the following scheme is to be followed: Suppose 12 children received these grades in arithmetic—A, 100; B, 90; C, 90; D, 85; E, 80; F, 80; G, 80; H, 75; I, 75; J, 75; K, 75; and L, 70. Then rank A as 1; B and C as 2½ (i. e., the average of 2 and 3); D as 4; E, F, and G as 6 (i. e., the average of 5, 6, and 7); H, I, J, and K as 9½ (i. e., the average of 8, 9, 10 and 11); and L, as 12.)

2. Obtain the differences in the *rank* of each individual in the two ratings (d).
3. Square these differences (d^2).
4. Obtain the sum of these squared differences (Σd^2).
5. Multiply this sum by 6 ($6\Sigma d^2$).
6. Count up the number of individuals being studied (n), square this number (n^2), subtract 1 from that ($n^2 - 1$), and then multiply the difference by the number ($n(n^2 - 1)$).
7. Divide the amount obtained in the 5th step by the amount obtained in the 6th step.
8. Subtract this decimal from 1.00, observing algebraic signs. This final decimal is the coefficient of correlation.

Here is the solution of the coefficient of correlation of the first set of figures. (Case 1.)

Initial ability		Final ability		Individual considered	Differences in rank	Differences squared
Rank	Individual	Rank	Individual			
1	B	1	G	B	1 − 4 = − 3	9
2	I	2	J	I	2 − 3 = − 1	1
3	J	3	I	J	3 − 2 = 1	1
4	C	4	B	C	4 − 6 = − 2	4
5	E	5	E	E	5 − 5 = 0	0
6	A	6	C	A	6 − 8 = − 2	4
7	G	7	H	G	7 − 1 = 6	36
8	F	8	A	F	8 − 9 = − 1	1
9	D	9	F	D	9 − 10 = − 1	1
10	H	10	D	H	10 − 7 = 3	9
					Total.........	66

Formula for coefficient of correlation (the letter "r" is the common abbreviation for this term):—

$$r = 1 - \frac{6\Sigma d^2}{n\,(n^2-1)}$$

d^2 = the differences squared, illustrated by the ten squared deviations in the last column.

$$r = 1 - \frac{6 \times 66}{10\ (100-1)}$$

Σd^2 = the sum of all the squared deviations, as 66 above.

$$r = 1 - \frac{396}{990}$$

n = the number of individuals being considered, as 10 in this case, i. e., the 10 individuals, A–J.

$$r = 1 - 0.40$$

$$r = +\ 0.60$$

The coefficient of correlation (r) between initial ability and final ability in the case of these 10 individuals is +0.60.

Here is the solution of the coefficient of correlation of the second set of figures above. (Case 2.)

Rank	Initial ability	Final ability	Differences in rank	Differences squared
1	B	G	−9	81
2	I	J	−1	1
3	J	I	1	1
4	C	E	−1	1
5	E	C	1	1
6	A	H	−1	1
7	G	A	6	36
8	F	F	0	0
9	D	D	0	0
10	H	B	4	16
				138

$$r = 1 - \frac{6\Sigma d^2}{n(n^2-1)} = 1 - \frac{6 \times 138}{10(100-1)} =$$

$$1 - \frac{828}{990} = 1 - 0.84 = +\ 0.16$$

What a Coefficient of Correlation Means

"Correlation expresses to what extent two traits vary coördinately, independently, or antagonistically."[1] For example, scholarship varies coördinately with intelligence, independently of an alphabetic list of the class and antagonistically to the presence of ill health. In other words, (1) the best scholar is most likely to be the brightest child in the class, the poorest scholar to be the dullest child in the class; (2) the best scholar is no more likely to be the student whose name is Aaron than Zullen, and

[1] Joseph Jastrow, *Character and Temperament*, 1915, p. 509.

the same is true respecting the poorest scholar; (3) the best scholar is most likely to be the child with the least sickness, while the poorest scholar is most likely to be the child with the most sickness.

A coefficient of correlation of +1.00 means that the two traits vary coördinately and perfectly so; a correlation of +0.75 means that the traits vary coördinately but not perfectly so; a correlation of 0 means that the two traits vary independently; and a correlation of −1.00 means that the two traits vary antagonistically. Coefficients of correlation range, then, from +1.00 through 0 to −1.00; any single number having a certain significance on a scale from coördinate variability, through independent variability to antagonistic variability.

The correlation of +0.60 which was obtained between initial performance and final performance in the mirror-drawing experiment means that on the whole the best at the start was best at the end, the poorest at the start was poorest at the end, the fifth at the start was fifth at the end, etc. If it had been exactly this relationship we would have had a correlation of +1.00. As we had less than +1.00, i. e., +0.60, it means that a few of the individuals were out of place from this perfect arrangement. This we find in the cases of G, B, and H; G advancing from seventh to first place, B dropping back from first to fourth place, and H advancing from tenth to seventh. Besides these decided changes in position, all the other individuals except E change place to a slight extent. Now in the case of our second case with its correlation of +0.16, we have a statement which indicates that there is practically no relationship between the two sets of figures. We can expect that only to a very slight extent will it be true that the best at the start will be the best at the end and the poorest at the start will be poorest at the end. Rather will we expect to find decided differences between the two groups of figures such as B's change from first to last place, G's change from seventh to first place, and H's change from tenth to sixth place.

Assignment for Laboratory Hour

Obtain the coefficient of correlation for the problems given below. Do as many of these problems as you can during the laboratory hour. Check up your answer for each example,

through consultation with the instructor, before going on to the next problem.

RECORDS OF TEN INDIVIDUALS IN MIRROR-DRAWING EXPERIMENT

Trials	A	B	C	D	E	F	G	H	I	J
1	232	76	210	363	216	286	283	701	129	131
5	133	70	108	132	110	97	76	98	84	75
10	88	54	71	121	75	89	56	72	55	49
15	89	53	60	86	75	81	43	55	59	38
20	61	50	58	85	52	70	35	60	40	36

1. Obtain the correlation between the fifth performance and the final performance in the mirror-drawing experiment.

2. Obtain the correlation between the tenth performance and the final performance.

3. Obtain the correlation between the fifteenth performance and the final performance.

4. Suppose the following grades had been given to ten students in High School, what would be the correlation between their grades in (*a*) algebra and English, (*b*) algebra and Latin, and (*c*) algebra and biology?

Students	Algebra	English	Latin	Biology
A	98	A	F	83
B	96	A−	D−	94
C	93	B+	D	86
D	89	B	C−	72
E	85	B−	C	91
F	84	C+	C+	88
G	82	C	B−	69
H	80	C−	B	95
I	75	D	A−	77
J	70	F	A	90

5. Answer the following questions:—

(*a*) What does a correlation of $+1.00$ mean?

(*b*) What does a correlation of -1.00 mean?

(*c*) What does a correlation of 0 mean?

(*d*) Could you have a correlation larger than $+1.00$ or smaller than -1.00?

6. Study these two statements until you feel that you comprehend somewhat of their meaning:—(1) Two individuals selected at random will have a correlation of 0 with respect to any trait, two brothers will have a correlation of about $+0.40$ with respect to any trait, and two twins will have a correlation of about $+0.80$ with respect to any trait. (2) Similarly father and son will correlate about $+0.30$ while grandfather and grandchild will correlate about $+0.16$.

Hand in your report drawn up in the usual way at the next class-hour.

LESSON 29

THE CORRELATION BETWEEN HUMAN TRAITS—PSYCHOLOGICAL TESTS

THE RELATIONSHIP BETWEEN HUMAN TRAITS

In our everyday life we are constantly contradicting the principles set forth in Lesson 25. For we speak of people as either good or bad, honest or dishonest, brave or cowardly, blondes or brunettes, tall or short, and so on. In this way, we divide people up into two or more groups. But the conception developed in connection with the surface of distribution was that individuals belong to one group with respect to any trait. We saw further in that lesson that individuals differ greatly in some traits, as in the case of intelligence, where they range all the way from idiots to geniuses. But the great bulk of individuals are all much alike and the number of individuals who differ from the average decreases very rapidly as the amount of that difference is increased.

In our everyday life we are also constantly contradicting another principle already touched on in Lessons 20, 21, and 28. For we assume that poor ability in one respect is *compensated* for by good ability in another. So we say over and over, "I never was any good in mathematics but always got good grades in languages," or vice versa. Or we say of a stupid boy, "He just can't get his school work but it's wonderful how handy he is with tools. You should see the table he made." We really mean in such cases that because the boy can't get his lessons, therefore, he is better than most boys in manual training. It would be very nice if this were the case. But unfortunately it is not. Many investigations in which correlations have been made between ability in two traits have shown that *negative correlations are seldom found.* This means that superiority in one trait is seldom accompanied by inferiority in some other desirable trait. In other words, superiority in one trait is usually

accompanied more or less by superiority in all traits and inferiority in one is accompanied by inferiority in all. Individual exceptions occur from time to time, but not so often as we popularly assume. The correlations between school subjects, according to Starch[1] are as follows:

Arithmetic and Language....	+0.85	Language and Spelling....	+0.71
Arithmetic and Geography...	.83	Geography and History....	.81
Arithmetic and History......	.73	Geography and Reading...	.80
Arithmetic and Reading.....	.67	Geography and Spelling....	.52
Arithmetic and Spelling.....	.55	History and Reading......	.67
Language and Geography....	.85	History and Spelling......	.37
Language and History.......	.77	Reading and Spelling......	.58
Language and Reading......	.83		

Starch goes on to state that "these correlations are almost twice as high as those previously quoted[2] and represent very close correlations. They would warrant the interpretation that the pupil who is good, mediocre, or poor, in a given subject, is good, mediocre, or poor, to very nearly the same, but not equal, degree in all other subjects so far as his abilities are concerned. Such lack of agreement as does exist is due probably to a difference of interest and industry on the part of the pupil in different subjects and to a real difference in abilities in the various fields. Thus spelling ability correlates apparently less closely with ability in other subjects than abilities in these other subjects correlate among themselves."

Many pages of data could be presented to sustain the point that "*intellectual and scholastic abilities are for the most part closely correlated.*"

How Coefficients of Correlation are Utilized in Psychology and Education

The correlations between various school subjects, just quoted, illustrate one use to which this mathematical method of measuring to what an extent two traits vary has been put. Such questions as this one and many others of a similar nature confront the psychologist and educator. Let us consider some other examples where correlation has been used.

[1] D. Starch, *Educational Psychology*, 1920, pp. 56–57.
[2] E. L. Thorndike, *Educational Psychology*, 1903, p. 37ff

The data on initial and final performance in mirror-drawing was reduced to the one figure +0.60, which expresses the extent to which these two abilities vary coördinately.

The writer[1] wished to determine whether the results he had obtained in rating the efficiency of advertisements by a laboratory method would check up with business conditions. He therefore correlated the results he had obtained by two different laboratory methods with each other and with the ratings of these advertisements as furnished him (a) by the owners of the business and (b) by the advertising agency representing the business concern. He obtained these correlations:—

Correlation between the results of the two laboratory methods	+0.95
Correlation between the results of first laboratory method and the company rating	+0.89
Correlation between the results of first laboratory method and the agency rating	+0.87
Correlation between the results of second laboratory method and the company rating	+0.84
Correlation between the results of second laboratory method and the agency rating	+0.92
Correlation between the company rating and the agency rating	+0.87

Apparently then the laboratory methods of estimating the efficiency of these advertisements were as accurate as the methods of the company or of its advertising experts. That meant that the writer who knew nothing about advertising in those days, nor about this particular business, could determine the efficiency of its advertisements as accurately as could the men who made these things their specialty.

Take another example. Yerkes of Harvard University devised a series of tests (The Yerkes-Bridges Point Scale Test) whereby the general intelligence of children can be estimated surprisingly accurately. Garrison[2] tried the tests on college students and obtained a correlation of only +0.19 between the ratings given the students by the Yerkes test and their college

[1] Edward K. Strong, Jr., *Relative Merit of Advertisements*, 1911, p. 11ff.

[2] S. C. Garrison, The Yerkes Point Scale for Measuring Mental Ability as Applied to Normal Adults, *School and Society*, June 23, 1917.

grades; also a correlation of +0.15 between the test ratings and the combined opinions of eight professors as to the students' general ability. Of course neither college grades nor the combined opinions of professors accurately portray the real ability of college students. We all know that. Still they are accurate enough so that if a test does not correlate with them more than +0.19 we judge that the test is practically worthless. This low correlation means, then, that Yerkes' intelligence test is of little value in classifying *adults* in terms of their general intelligence. It is, on the other hand, as already stated, of real value in classifying children.

When Kelley[1] attacked the problem of how far he could go in prophesying what a student would do in high school on the basis of his records in grammer school, he obtained the correlations between the student's grades in the 4th to 7th grades (a 7-year grammer school was studied) and in the first year of high school. The final correlation was found to be +0.79 between grammar school and high school work. Kelley urges on the basis of his study that the grades of a child should be kept on a card for his entire school career, since they form the very best basis now obtainable from which we can estimate what a child will do in higher schooling. And it is quite likely when we come to know more about vocational guidance that we shall find these records of great value in scientifically guiding boys and girls into the careers for which they are most adapted.

These examples are only three out of hundreds that might be given all going to show how necessary it is to obtain a coefficient of correlation in order to solve many psychological and educational problems. At the present point in this course all that is desired is that you obtain an idea of how the correlation is obtained and something as to what it means. As you progress in your training along psychological and educational lines you will run across this topic again and again and after a time you will commence to feel at home with the subject. What a correlation means is a difficult conception to acquire and cannot be gotten in a few minutes or even in a few hours. It requires time in just the same way that it takes time to familiarize oneself with the centigrade thermometer or the metric system so that the various figures are immediately comprehended.

[1] Truman L. Kelley, *Vocational Guidance*, 1914.

Psychological Tests

One of the fields of research in which correlation has been used most extensively is that of developing tests to measure mental ability. Here we have the task of devising some test and then determining just how closely the scores in the test agree with the measure of the individual's ability in some other respect—the latter is spoken of as the *criterion*. For example, we are interested in devising tests which will determine who can and who can not profit by a college education. When the test scores have been obtained, they are correlated with the grades these same students get in their college work. If the correlation is high, we decide that the test is a good one; if the correlation is low, the test is discarded or radically revised. In this way we test out the test before putting the test scores to use.

Three types of psychological test are employed today:—(1) the intelligence test, (2) the trade or educational test, and (3) the vocational guidance test.

Intelligence Tests

The intelligence test measures the mental alertness of the individual. To the writer the intelligence test measures the ability to learn and to retain what is learned. Possibly, in an indirect way, it is a measure of the chemical changes that take place in the brain which account for learning and retention. Psychologists are pretty well agreed that the capacity which is measured is innate and is very little affected by education or experience.

The most famous intelligence test is that of Binet and Simon, two French psychologists, who first published their test in 1908. Its 1911 revision has been used very extensively. The Stanford revision,[1] the work of Terman, is accepted as one of the best tests of the sort for American children. The six year old test is as follows:—

1. The child is asked, "Show me your right hand," then left ear, right eye, left hand, right ear, and finally the left eye. He

[1] L. M. Terman, *The Measurement of Intelligence*, 1916. (Used by permission of, and by special arrangement with, Houghton Mifflin Company, the authorized publishers.)

must get three correct out of three, or five correct out of six, or no score for this part is credited. If he gets the five correct, it counts "two months," as do each of the remaining five parts.

2. The child is shown four pictures of human beings. In each picture a part is missing, as, the eye, the mouth, the nose, the arms. The child must point to the missing part in three of the four pictures, not consuming more than 25 seconds for each picture.

3. The child must count correctly 13 pennies. He is allowed two trials.

4. He must show his comprehension of two of these three questions:

(a) What's the thing to do if it is raining when you start to school?

(b) What's the thing to do if you find that your house is on fire?

(c) What's the thing to do if you are going some place and miss your train (car)?

5. When asked "What is that?" and at the same time shown a "nickel," he must reply correctly. Also with "penny," "quarter," and "dime." Three out of four must be named correctly.

6. He must repeat correctly word for word, after one reading, one of the following three sentences, or repeat two of them with not more than one word incorrect in each.

(a) "We are having a fine time. We found a little mouse in the trap."

(b) "Walter had a fine time on his vacation. He went fishing every day."

(c) We will go out for a long walk. Please give me my pretty straw hat."

The child is given such questions and scored in terms of what he can do. The total gives his *mental age*. Thus, he may be actually six years and six months old but scores in the test seven years and six months. He is spoken of as 7½ years mental age; or one year older mentally than actually.

Another measure is employed in this connection. That is the *Intelligence Quotient* (*I.Q.*). It is found by dividing the mental age by the actual age. In this case it would be 115 (dropping the decimal point).

There are today a great variety of intelligence tests, many constructed quite differently from this one. The test known as Army Alpha was used to grade soldiers during the late war. It contained 212 questions. The numerical score was stated in terms of A, B, C+, C, C−, D, and E. (Refer to Lesson 25 where certain results of this test are discussed.)

Twenty of the 212 questions were simple problems in arithmetic. Sixteen of them were as follows:—Check the best completion to the statement "Gold is more suitable than iron for making money because gold is pretty ( ), iron rusts easily ( ), gold is scarcer and more valuable ( ). Another part of 40 questions necessitated that the word "same" or "opposite" be underlined according as the paired words meant nearly the same, or nearly the opposite. The first and last three pairs were:— "cold—hot," "long—short," "bare—naked," "lugubrious—maudlin," "desuetude—disuse," "adventitious—accidental." (The words "same—opposite" were printed opposite each of the forty pairs.)

The Binet test is typical of an individual test as it is so constructed that it must be given to one individual at a time. The Army Alpha is typical of a group test; several hundred can be tested at one time. Individuals may be easily classified into groups on the basis of one or more group tests. In many cities children are so classified and placed in special classes for the mentally defective, the dull, the average, and the superior. But when careful diagnosis of an individual's mental condition is necessary, this has to be done by individual examination.

Use of Mental Tests for College Entrance.—Considerable interest has been recently aroused by the introduction of mental tests as part of the machinery for deciding whether this or that student should be admitted to college. The time has not yet arrived definitely to evaluate their use in this connection. But let us consider one such study by Thurstone[1] as to the relationship between scores in mental tests and scholastic work in college.

The Freshman students in the Margaret Morrison College of Carnegie Institute of Technology were given six different tests and the scores combined into one final rating, so calculated as to range from −25 to +105. The distribution is shown in Plate

[1] L. L. Thurstone, Mental Tests for College Entrance, *Journal of Educational Psychology*, 1919, pp. 129–142.

XXXI. The lower *critical score* at +10 was selected so as to divide off "the largest proportion of failures without excluding any students who have made good." If the Freshmen who fell below this critical score in their test papers had all been refused admission then seven out of the eleven who were flunked out would have been eliminated at the start. Furthermore, eight of the seventeen who were placed on probation for poor scholarship would have been eliminated. And at the same time, not one of the students who was able to carry the work would have been prevented from getting a college education. It would probably

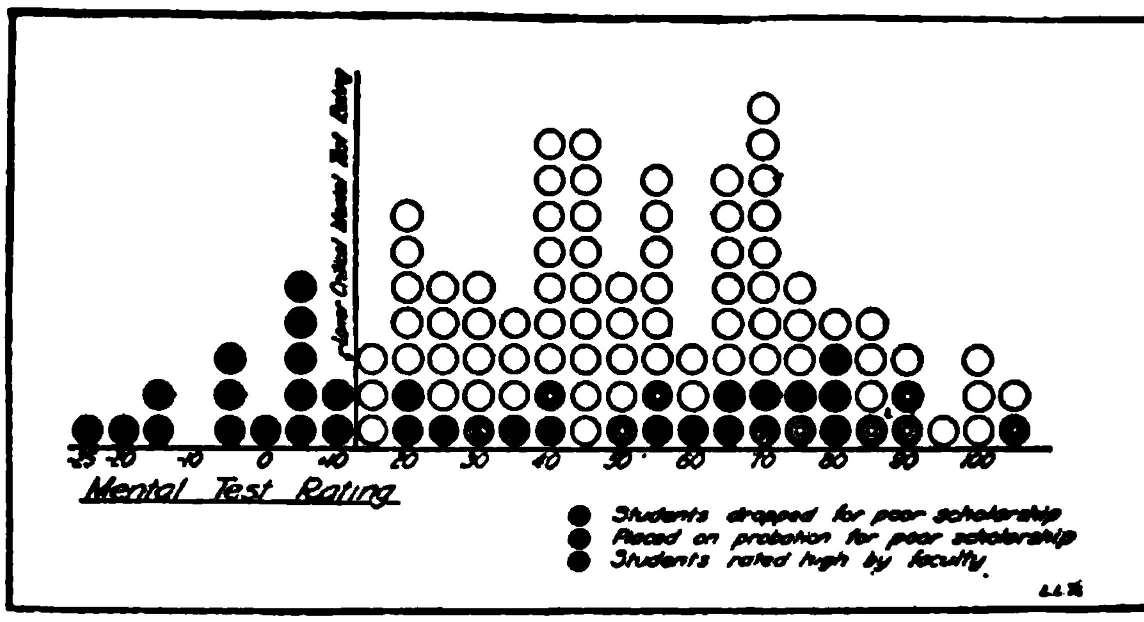


Plate XXXI.—Showing distribution of Freshmen in terms of mental test scores; also the scholastic records of the young women.

have been better to save these fifteen young women the discouragement which comes from failure and to advise them to take up some other work.

In Plate XXXII we have what is technically called a *scatter diagram*. On it each Freshman is shown as a dot, so placed as to indicate (*a*) the intelligence test rating and (*b*) the combined estimate of her instructors. (These estimates range from 1 to 10, 10 being the highest estimate.) Thus the student at the extreme lower left hand corner received a mental test rating of −20 and the instructors' estimate of 1, whereas the student at the extreme upper right hand corner received a rating of +105 and an estimate of 10. The correlation here between intelligence test ratings and combined instructors' estimates is +0.60.

Two critical scores are shown in this plate. All the Freshmen rated below the lower critical mental test rating (+10) are below the average in the opinion of the faculty and all who scored above

the upper critical mental test rating (+85) are rated above the average in the opinion of the faculty.

The correlation of +0.60 tells us here how close the relationship is between test ratings and the instructors' estimates. The critical scores mark those points at which we can divide the group into three parts, so that all the inferior students in both

PLATE XXXII.—Scatter diagram showing relation between instructors' estimate and mental test rating.

test and instructors' estimates are at one end, all the superior students in both cases are at the other end, and the remainder of the students are in between. Such conditions are essential if good diagnostic results are to be obtained.

TRADE AND EDUCATIONAL TESTS

What is needed in schools and industry is tests that measure ability to do certain specific work, such as column addition, with a specified degree of speed and accuracy, handwriting of such and such merit, driving an auto truck up to standard requirements, or doing the work of a journey man carpenter. Such tests differ from intelligence tests as discussed above for they measure specific ability (or performance) to do a definite task at this time, not general ability. The Kansas Silent Reading Test (Lesson 21) is typical of many educational tests. Plate XXXIII shows a portion of the Thorndike Handwriting Scale. The handwriting of any individual can be compared with the specimens in the scale and graded accordingly.

The norms proposed for handwriting in terms of this scale are:—

Grade	II	III	IV	V	VI	VII	VIII
Speed[1]	35	45	55	64	72	77	80
Quality:							
Usual	7.0	7.8	8.6	9.3	9.9	10.5	11.0
Best	8.5	9.3	10.1	10.8	11.4	12.0	12.5

During the war thousands of soldiers were trade-tested in order to determine how good they were along certain occupational lines of value to the army. Men claiming auto truck driving experience, for example, were required to drive a truck over a standardized course on which they were scored on certain specified points, as, for example, driving forwards and then backwards over an S-curve without running off the road. In this way the truck driving ability of each of such soliders was measured according to a standardized procedure and so expressed that every trade-test officer understood just what it meant. (Contrast this highly standardized method of measurement with our present inability to state what a 4th or 12th grade student can do.)

Vocational Guidance Tests

Vocational guidance tests differ from both intelligence tests and trade tests in that they are made to indicate *future* ability to do certain *specific* work after the individual has been trained

[1] Speed indicates "letters per minute" without substantial loss in quality of writing, when the material being written is so familiar as to require no time for study or reflection, and when the total time of the test trial is not over three minutes.

Usual Quality, the quality used by the pupil in history, geography or composition papers, is probably a better practical index of efficiency than the writing done in the writing class or under instructions to "write as well as possible."

Best Quality indicates the quality written when the instructions are to "write as well as you can." The above standards are the medians that may reasonably be expected at the middle of the second half year in each grade, where the school is fairly typical of American public schools in its population and is well organized.

for the work, whereas intelligence tests measure *general* ability to learn and retain, and trade tests measure *present*, not future ability. When really serviceable vocational guidance tests have been developed it will be possible to foretell whether an individual can make good or not along this or that line.

Very few such tests are in existence today. Probably the best developed series is that of Seashore[1] for determining musical ability. The Bureau of Personnel Research at Carnegie Insti-

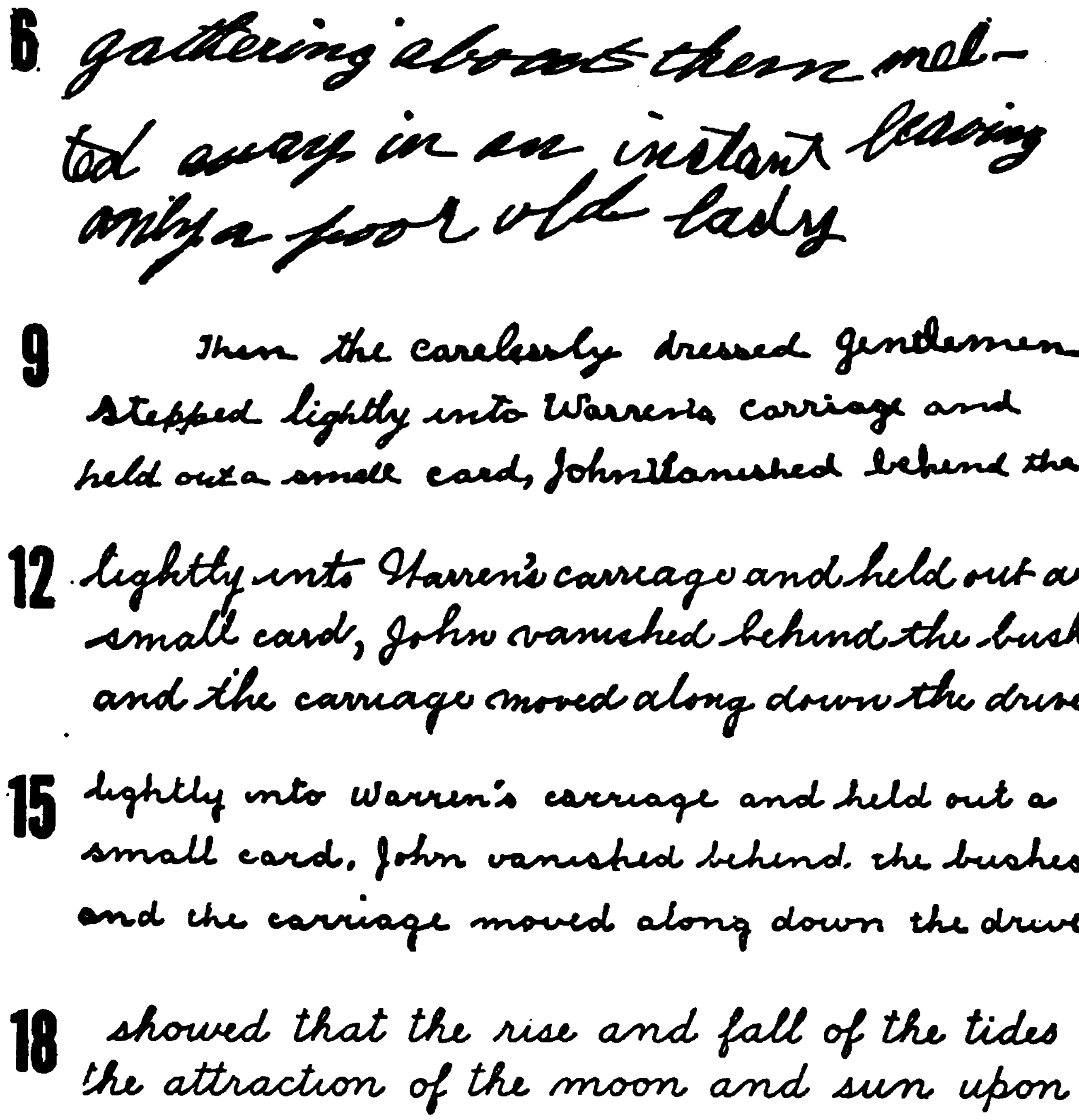


PLATE XXXIII.—Samples taken from Thorndike Scale for Handwriting.

tute of Technology is engaged in developing trade and vocational guidance tests which will indicate whom to hire and whom not to hire as salesmen for life insurance companies. In Plate XXXIV is shown one of the latest developments in this field. Seventy-five men and women in the School of Life Insurance Salesmanship were given five tests and an extensive application blank to fill out. The combined scores from all six blanks are

[1] C. E. Seashore, *Psychology of Musical Talent*, 1919.

LESSON 30

SUMMARY OF LESSONS 19 TO 29

The first part of this text-book has dealt with the learning process, and the second part with individual differences. A third general conception has been developed as to the meaning of Situation, Bond and Response. These conceptions can be schematically represented by the learning curve, the surface of distribution and by the letters S–B–R.

What has been covered in this second part may be grouped under six main heads:—

Causes of Individual Differences

A great number of factors combine to produce any one individual. How many these are and what they are is largely unknown. The thyroid gland has been pointed out as one such factor. But there is little ground to believe that it is a factor independent entirely of other factors; rather it is to be supposed that it affects many other factors and that they in turn affect it.

All the factors that affect an individual and so cause him to differ from other individuals may be grouped under the two heads of heredity and environment. Each individual is born with a certain combination of factors. And each individual is confronted with a different environment from all of his fellows. What he finally becomes is due to the effect of these two. The modifications of his native behavior due to efforts to adjust himself to his environment is called training. Training is thus always a composite of heredity and environment. In lessons 31 to 50 many additional facts will be pointed out showing just how heredity and environment contribute toward training.

How Individuals Differ

Contrary to popular notion, men do not divide up into two or more sharply defined groups or types. Instead, in nearly every

case, they are found to all belong to *one type.* But not all members of the type are alike; they all differ more or less. Their differences may, however, be viewed as variations from a central tendency, or average individual. And, moreover, many individuals are found to differ only a little from this central tendency and only a very few individuals to differ greatly from it. The normal surface of distribution pictures this conception.

In comparing individuals who belong to different groups, such as whites and negroes, or army officers and enlisted men, or fourth grade and eighth grade children, it is found that members of the two groups *overlap;* that seldom is there a sharp break between two groups. So true is all this that it is extremely difficult to find methods to distinguish between members of different groups. But until such methods are discovered the sciences of employment management and vocational guidance cannot be established.

In the specific field of learning, individuals differ with respect to initial performance, amount and rate of learning, and final performance. The effect of heredity and previous training upon these three has been pointed out.

How Traits or Abilities Within One Individual are Related

Here, again, popular opinion has been found to be in error. An individual who is superior in one trait tends to be superior in many traits. Nature does not usually *compensate* for weakness in one ability by developing another to make up for it. In other words, desirable traits, for the most part, correlate.

There is, however, considerable truth in the popular view, when viewed from another angle. The child, for example, who is awkward in athletic games goes off and does something else. Later in life he may be noted for the musical talent which would not have been developed if he had played like other boys. The key to an understanding of many a person's behavior is a knowledge of his former failures, for by now they are covered up as well as possible and compensated for through interest in other activities. Often, although not always, the failures remain sore points and unexpected reactions occur when they are touched upon. The story in Lesson 1 of the man who objected to the

church bells is an example of an unexpected reaction because of the soreness of failure.

The Basis from Which to Measure Individual Differences

Any group of individuals, barring exceptional cases, are distributed about a central tendency, as pictured by a surface of distribution. The natural point from which to measure how each individual differs from the group is this central tendency, or position of the average person. Each individual can then be thought of as so much superior or inferior to this central tendency. Now this is just what a man ordinarily does when he expresses a judgment about another. He states that the other one is tall or short, good or bad, educated or uneducated, in terms of his notion of what an average man is in that respect. So the most prominent minister, or doctor, or school teacher, or carpenter in a small town is rated very superior, just because he is superior to the average in the town. In terms of average ability in his line in the state he may be quite inferior. But an interesting aspect of such judgments is that the average man does not realize he is making judgments in terms of a central tendency; he thinks he is making them in terms of perfection. Grades in school are always viewed as expressing the percentage of perfection attained by the child. The two lessons on grading students make clear that this is not and cannot be the case.

Norms have recently been developed to enable judgments to be made in terms of definite standards which all can understand. A norm, we have seen, is a measure of what an average person can do, based on measurements of a large number of individuals. So we have today norms for the various grades in certain work in arithmetic, for handwriting, spelling, and the like. In the future norms will exist for a great deal of school work and for much in industry. A norm is not, however, a standard of perfection, but a standard in terms of average performance.

In the field of testing general intelligence, or mental alertness, mental age is employed as a measure. It is often divided by actual age giving a quotient or ratio, called the I.Q. The intention is to have this I.Q. so standardized that the decimal 1.00 will represent normal ability, i. e., the proper mental develop-

ment for the individual with that actual age. And the word "proper" means in this connection that mental development which goes on the average with the given actual age.

Statistical Tools in the Study of Individual Differences

An introductory psychology is not the place to stress statistical methods. But without comprehension of certain statistical tools one can hardly understand many important facts and principles dealing with individual differences.

There are three measures of the central tendency. Everyone is familiar with the *average* of a set of figures. But few are at all familiar with the other two measures—median and mode. The method of obtaining them can be illustrated from the data given in Table VII. The *median* means the middle datum when all the data have been arranged in order of merit. Thus the median performance in the fourth grade would be 6 problems attempted and 3½ problems solved correctly, for 50% of the pupils did better, or equal to, 6 and 3½ respectively, and 50% did poorer, or equal to, these two medians. The *mode*, on the other hand, means that performance which is typical of the largest number of individuals. Thus, the mode would be 6 problems attempted (21% did 6 and only 14% did 7 or 5) and 3 and 4 solved correctly (14% did both 3 and 4). In the latter case there are two modes, is quite often the case.[1] The mode is not used very often, but the median is used very frequently in the field of educational psychology. It has this decided advantage over the average that it tells at what point a class, for example, is divided into two equal parts, so that half of the students are superior to the median and half inferior.

Measurement of variability of a group from its central tendency is obtained by the average deviation. There are other measures but lack of space forbids mention of them.

A complete expression of both central tendency and variability is afforded by the surface of distribution.

[1] The student who is interested will find it worth while to refer to E. L. Thorndike, *Theory of Mental and Social Measurements*, 1913; H. O. Rugg, *Statistical Methods Applied to Education*, 1917; or C. Alexander, *School Statistics and Publicity*, 1919.

The relationship of one trait to another is measured by the coefficient of correlation. It may be pictured by a scatter diagram.

METHODS OF MEASURING INDIVIDUAL DIFFERENCES

When considering psychological factors, individuals are usually measured from a central tendency or norm. But they are measured by means of some test. When a measure of general native ability is desired, some form of intelligence or mental alertness test is employed. When a specific native ability is to be measured the appropriate vocational guidance or aptitude test is employed, and in some cases an interest analysis blank is also used. When a measure of training along some line is desired, the appropriate trade or educational test is used. The better the aptitude test is, the more it measures ability in the one trait under study and the less it is affected by ability in other lines. Similarly, the better the trade or educational test, the more it measures specific training as expressed in doing a certain performance and the less it is affected by general ability.

Certain general applications naturally follow:—

APPLICATION TO SOME EDUCATIONAL PROBLEMS

Learning has been reduced to making connections—forming new bonds. And *teaching* consequently becomes the art and science whereby proper situations are presented so that children will react as desired. In so reacting new bonds are constantly being formed and old bonds as constantly being strengthened through use.

The problem of individual differences is a very big problem in the educational world and must be taken into consideration in teaching and administrative work. Children differ very materially. Such differences are caused jointly by heredity and by training. The differences in training can to a large degree be taken care of through putting those with extra training ahead of those with less training. But the differences due to heredity cannot be disposed of so easily. Superiority in heredity means that the child is going to advance rapidly; inferiority in heredity means that the child is going to advance slowly. This is shown

diagrammatically in Plate XV. It means that any class always tends to fly apart. The more training a group has, the more the children are going to become unlike. Training does not make people alike, it makes them unlike. The bright child gets all of his lesson, the dull child but half. The next day the bright child gets all of the new lesson; the dull child cannot do as well as he did before, because part of the new lesson depends on that part of the first lesson he didn't get. He consequently gets less than half of the second lesson. So as time continues the gap between the two widens.

As things are conducted today, average children are fairly well taken care of. The pace set is too slow for the bright children and too fast for the dull children. The bright children are not encouraged to work hard. They can easily get their lessons in a few minutes "any old time." The dull are discouraged for they can't possibly keep pace. What is needed today is a system so elastic that all can keep working at their own pace. Some advocate here that the pace be set for the dull child and the better children be persuaded to do more work on the side and in a better manner. The dull child will then get the sheer essentials, the others a richer and richer course depending on their ability. But how is such a course to be conducted? Others advocate various schemes for rapid or slow promotion depending on the different children.

With the use of an intelligence test the innate mental alertness of each child can be determined. Such results are being used to solve this problem of properly grading children. In this way children of the same intelligence are put together. Such a plan is easily workable in a large city school system where there are several sections in each grade anyway. It is not so easily applied to small school systems.

Another problem is immediately brought to the fore as soon as such a classification of pupils on the basis of intelligence is accomplished. Shall the bright pupils be allowed to finish the grammar school in considerably less time than average children? Many have advocated this. Others have advocated an enriched curriculum for the brighter children so that they will spend the same time in each grade that average children spend, but cover much more ground. The best argument in favor of the latter program is that bright children may be superior to average chil-

dren in intelligence, yet many of them are no more advanced than the average child in emotional development. And the child's best social development comes from having him with those of the same emotional development. If high schools and colleges should sometime be organized to take care of highly intelligent but socially immature pupils, then it might be wise to force bright children ahead; but until that time, an enriched curriculum seems to the writer the best procedure in the handling of superior children.

One teaching device based on the principles covered in this test should be considered in this connection. It is embodied in the *Courtis Standard Practice Tests.* These are drill blanks given to children in the grades and so arranged that each child can progress as fast as he is able, but the whole class is kept busy at the same time. The first two tests and the record sheet covering these tests are shown in Plates XXXV and XXXVI. On the first day every child is given a copy of Lesson 1. Suppose it is a 4th Grade class. The children are then allowed 6 minutes to do the lesson.[1] At the end of the six minutes the papers are corrected and each child records his record in his Record Book. On the second day, if any child finished the first lesson correctly within the six minutes he is not required to do Lesson 1 over again but is supplied with Lesson 2 instead. The remainder of the class repeat Lesson 1. So it goes throughout the year. It is conceivable that after forty-eight days a very bright child would have entirely finished all 48 lessons whereas a very dull child would still be on the first lesson. Courtis, however, advocates that after several failures, individual instruction be given the backward child and if that is not sufficient to bring him up, that he be allowed to go to the next lesson. In Plate XXXVI are shown two individual records on the one sheet. (Ordinarily only one record would appear on a page.) N has required 15 days in which to finish Lesson 1. The solid line traces the number of problems he did each day and the broken line the number he got correct. M, on the other hand, finished Lesson 1 in five days and Lesson 2 in two more days. (As there are but 61 problems in Lesson 2, 61 is of course the standard set in that lesson.) His record for Lesson 3 would be scored on another page

[1] The other grades are given a shorter time. The 5th grade is allowed 4¾ min.; the 6th grade 4 min., the 7th grade 3½ min., and the 8th grade 3 min.

and so does not appear here. He finished up four lessons while M was doing one.

The point to be noted about this scheme is that it provides a method by which the entire class can be put at arithmetical work

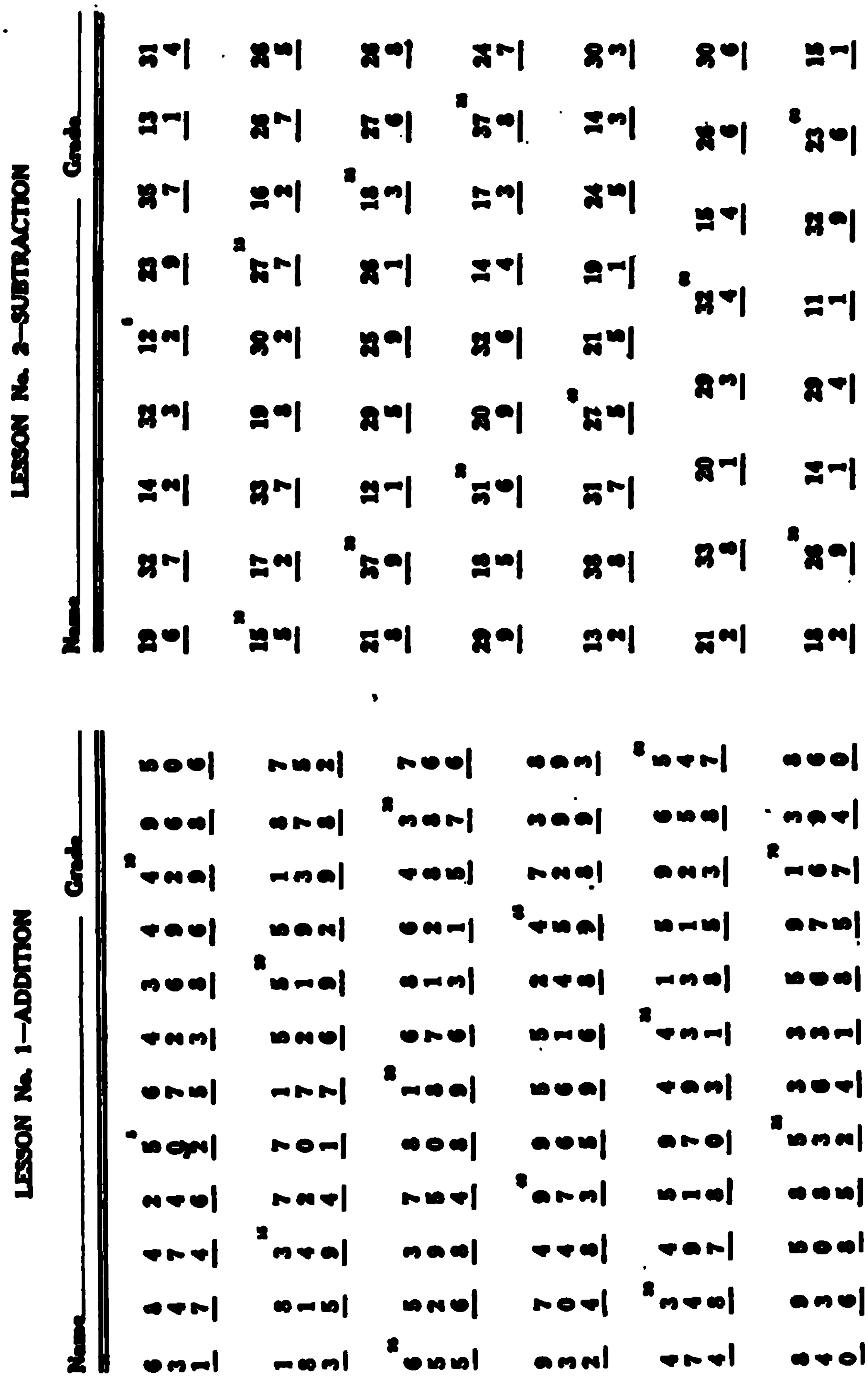


PLATE XXXV.—Courtis Standard Practice Tests.[1]

and at the same time the lessons may be varied in accordance with individual differences. Moreover each child plots his own

[1] The latest edition of these practice tests shows Lesson No. 1 as above. But Lesson No. 2 now comprises 70 problems instead of 61. The Graph Sheet in Plate XXIX is also from an earlier edition of the "Student's Record and Practice." (By permission of World Book Company.)

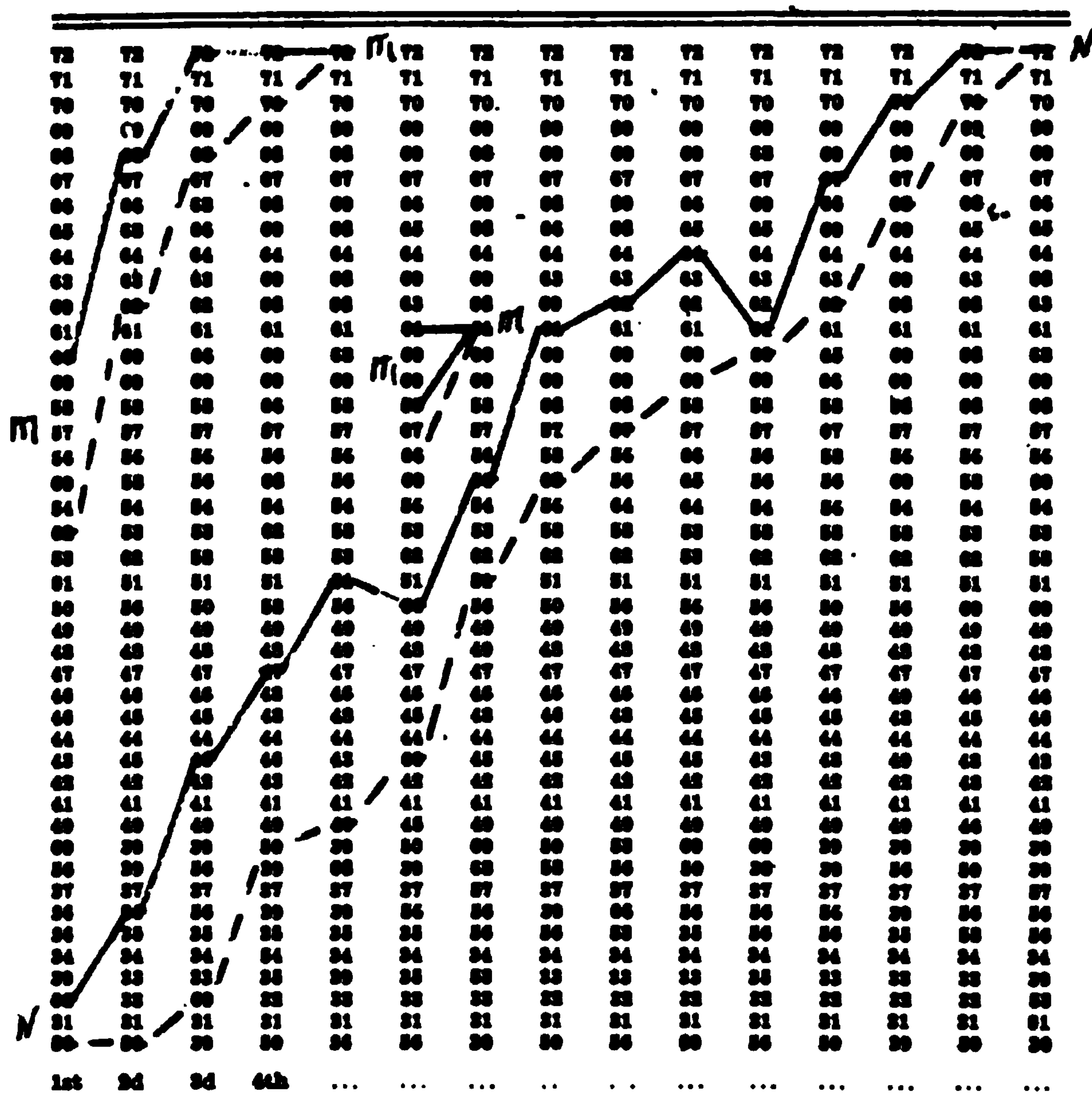
learning curves and so knows just how he is advancing day by day. He has the stimulation of racing against others and also against himself. This whole procedure is typical of a general method that can be employed by most teachers.

GRAPH SHEET

FOR

Lesson No. 1 . . 72 examples Lesson No. 2 . . 61 examples

LESSON NO.



INSTRUCTIONS: After each trial, in the column corresponding to the number of the trial, draw a short horizontal line through your score in examples tried. Using a ruler, draw a heavy line from this point to the score marked in the previous column. In like manner draw a curve for Rights, using a heavy broken line. More than one graph can be drawn on this page; see Model, page 4. When you have completed the lesson successfully, hand in this record book with your paper.

PLATE XXXVI.—Graph sheet. Showing record of two children, M and N. M finishes Lesson No. 1 in 5 days and Lesson No. 2 in two days more. N requires 5 days to complete Lesson No. 1 in the allotted time.

An entirely different scheme for providing for individual differences is utilized in this course. Each lesson contains as many "leads" as even the best student will have time to follow. Every minute devoted to study is sure to add something to his training or store of information. At the same time each

lesson is easy enough so that the poorest student, deserving only to pass the course, can obtain sufficient grounding in the fundamentals of the course to pass and go on. The better the student, the more thorough a grasp of the material will be obtained, but all will get a worth while amount. If two or three times as much time were devoted to the course, the poorer students would get more from the course, but the better students would not be kept busy and so would not get the maximum training they have a right to receive in return for their tuition and time.

Realization of what this problem of individual differences means gives us a new point of view with regard to the whole subject of education. The overlapping of children in the several grades is being studied from many angles and ere long a more satisfactory solution of this phase of individual differences will appear. The old schemes for grading students are doomed and new ones based on our further knowledge of how children differ are taking their place. Because of better and better understanding of what each child can do and is best fitted for, there will result less antagonism to education and social authority and happier children, parents, teachers and supervisors.

Not only are the problems of education viewed in a new way but also all social problems. The handling of criminals, of paupers, of incompetent workers, of insane, of all exceptional individuals, has become a different proposition. Changes in our penal institutions, the rise of Juvenile Courts, of indeterminate sentences, of parole from penitentiaries, the interest in eugenics, in scientific vocational guidance, in personnel work, etc., are all related to each other—all manifestations of the view that individuals are not all alike nor can they be divided into sharply contrasting types, but that all are merely variations of greater or less degree from the average.

The student who has not simply learned about these things but has formed the habit of analyzing educational problems into situations and responses has gained something which will help him in all his work. As an aid in making such analyses this course has been devised so as to develop habits of solving problems by asking these questions:

1. What specifically is my problem?—the problem.
2. How may I study this problem?—the procedure.

3. What are my facts?—the results.
4. What do the facts mean?—the interpretation.
5. How can I use the deductions?—the applications.

Whether a student has got these things from the course or not eventually comes down to whether he has the ability to acquire such complicated conceptions (bonds) and has had the industry to develop them.

INTRODUCTORY PSYCHOLOGY

BOOK TWO

LESSON 31

WHY ONE BEHAVES AS HE DOES[1]

In Lesson 1 a great many questions were asked beginning with the word "Why": for example, "Why did Sam and Mabel enjoy being together? Why did Mabel get mad at Sam?" But no attempt was made to answer these; instead, we considered the "how" of the mental phenomena indicated by them. By now, having gained a fair comprehension of how individuals learn and how they differ, we may with some profit attack these "why" questions. To do so brings up for discussion the subject of *motives*. Why does one do this and not that?

The lessons that follow will, in general, consider first, why man acts as he does, and second, how one may get another to do what one desires him to do.

Wants

Why does an apple fall to the ground? "The law of gravitation," we answer. And by that we mean that matter attracts matter. Why does matter attract matter? No one knows the answer to that. As far as we know, it just does. Why does light travel at the rate of 186,000 miles a second? We know it does, but we don't know why. Science has been able to answer thousands of questions commencing with "what" and "how" but can answer very few questions commencing with "why." And if a second "why" is asked regarding the answers given by science to the first "why," the reply can only be, "It just *is* that way."

The same situation holds true in psychology as in all other sciences. The *why* of behavior can be traced back one or two steps, and then it stops. But it will be observed that the final answer always includes the verb "want" or its equivalent.

[1] What is presented in this lesson need not be fully understood just now. But it is the key to the lessons following. Comprehension of it will aid in grasping them, and as they are absorbed, this chapter will in turn become more and more intelligible.

When a small child is asked why he does this and not that, he replies, "I want to." To the child that is final; and it is final. The woman's "because" is the same sort of answer. She does this, or asks for that, because she wants to act in this way, or to get that thing. When a reason is given under such circumstances, the individual, as we shall come to see, is endeavoring to cover up his real motive or to justify his action to himself and to other individuals. Consequently, whenever a reason is given we may be sure we have not reached the bottom of the matter: We can always ask another "Why."

To understand the why of human behavior is, then, the problem of comprehending what are the *wants* of man. We shall not be able to go behind them; all that is possible is to know that they exist and that they determine behavior. What these wants are will be revealed in later lessons, where it will be shown that they are expressions of the needs of the body and of our native behavior—our reflexes, instincts and emotions.

Wants are Fundamental to Behavior.—"The starting-point of all human activity is the existence of wants. To satisfy hunger and thirst, to secure shelter, and to provide clothing were the chief aims of primitive man, and constitute even today the motor forces of all society. As man develops, his wants grow in number and refinement. However civilized he becomes, his material welfare forms the basis on which the whole larger life is erected. To secure the means of satisfying wants brings into play the economic activity of man. The process may be expressed in the words wants, efforts, satisfactions. We start out with the existence of wants, we desire to secure their satisfaction, we can ordinarily accomplish this only through some effort. The economic life of man is concerned with such efforts and their results."[1] So begins a standard text-book in economics.

Wants are the starting-point in explaining behavior; they are the keys to an understanding of human beings. It is with these that an educator must commence.

Wants Must be Controlled.—But although wants are the natural causes of action, it is undesirable that they should continue to control behavior throughout life. Too often they lead to injury and even death. Just because this is true, society has erected all kinds of safeguards to prevent the child, and even the

[1] E. R. A. Seligman, *Principles of Economics*, 1908, p. 4f.

adult, from acting in terms of his wants. Legally, a child may not buy anything, for he is prone to spend his money foolishly. Lotteries, gambling, and drink are stimuli that society has deemed best to remove from man, for although he would like to respond to them, no real need would be supplied by such response. Truly, much has thus been accomplished by legislation in modifying man's environment, by taking away certain stimuli and adding others. But the most thoroughgoing way to protect man against his wants is through education: through modifying and redirecting his wants. In this way he is taught to stop, before acting in terms of a mere want, and to think out the consequences. Before letting himself suffer from a stomachache, for example, he may decide that the fun of eating green apples will not be worth while.

Wants Must be Understood.—If wants are the chief causes of behavior, and if frequently they are unsafe guides in life, then those who would train others ought to understand the nature of wants and how they may be modified and controlled.

The remainder of this lesson will be devoted to the general characteristics of wants and some of their relations to behavior in general. In subsequent lessons details of many of man's wants will be considered.

Characteristics of Wants

As Distinguished from Needs.—A *want*[1] may be distinguished from a *need* in that a want is an expression of dissatisfaction, whereas need refers to that which is required for the best interests of the organism. Thus something good to eat is *wanted*, but nourishment is *needed*. Wants and needs are practically identical in many cases, but not in all. So the child wants to eat, and that is needful; he wants to play rather than to go to bed, and

[1] The word "want" is not entirely satisfactory in this connection. If its customary use were restricted to the colloquialism of "I want" it would be adequate. But unfortunately it does convey other meanings. The term "urge" conveys the idea of force or impulse, but not sufficiently the idea of desire. "Wish," on the other hand, emphasizes desire, particularly intellectually conceived desire, but implies, as also does "longing," a present inability to act as desired. "Want" as used here implies *desire* plus *impulse to act in accordance with the desire* so that existing dissatisfaction will be changed to satisfaction. Furthermore, "want" is not used here as synonymous with "need," which is conceived as referring to that which is necessary on other grounds than the mere elimination of dissatisfaction.

that is the opposite of what he needs; and again he does not want castor-oil when sick, but he needs it. In behaving in terms of a want, one is seeking to escape dissatisfaction and to obtain satisfaction right now; in behaving in terms of a need, one is taking into account the effects which will result in the future. An acquaintance likes strawberries very much, but they always make her sick. If she eats them, she satisfies a want; if she does not eat them, she supplies a need. So also, a business man may not want to take exercise, but he may need it in order to be in good health ten years later. He may satisfy his want and not supply his need, or vice versa; better still, he may satisfy both by developing some hobby, such as golf, which will give him both pleasure and exercise.

A few further illustrations may make this clearer. We need to breathe air, because if we do not we shall die within a very few minutes. Ordinarily there is no conscious want here, because before the want becomes strong enough to be conscious we satisfy it by taking the next breath. But when the breath is held, then the want is experienced consciously. Needs may consequently be viewed (1) as constant factors, or practically so, and (2) as either (*a*) consciously known or (*b*) unknown. Thus, a man is conscious of his need of nourishment, while a baby needs nourishment but is not conscious of his need. In the baby's case, when the need becomes great the baby is dissatisfied, and cries and struggles. Again, a person with malarial fever needs quinine, but usually he is unconscious of this need. It is brought to his attention by a physician, who knows the need in such a disease. Wants, on the other hand, are not constant factors, but constantly fluctuate. They, like needs, are either consciously known or unknown. In breathing there is a pendular swing back and forth from satisfaction (no want) to slight unconscious dissatisfaction (slight want); in the matter of eating in the case of adults, there is a swing from satisfaction after a meal to conscious want of food. If one ate but once a day there would be a back-and-forth swing but once a day, instead of three times, but the swing would be greater, i. e., from zero to extreme dissatisfaction. The same conception can be applied more or less to all man's wants. For example, the want of shoes fluctuates from unconscious want to conscious want.

To repeat: The intensity of a want fluctuates from zero to

strong conscious dissatisfaction. Furthermore, until a want reaches a certain intensity it is below the threshold and is unconscious. The quality of the want also may change. It may be a vague, restless dissatisfaction or it may be a specific desire for something. A "hunch" may be viewed as half-way between dissatisfaction without knowing why and dissatisfaction focused on some specific cause. The need, on the other hand, is an expression of the best interests of the individual. Natively, it finds expression in a want; for example, when food is needed a want is experienced. Through experience, needs become intellectually known and are then expressed in terms of reasoned-out statements.

A Want is an Expression of Dissatisfaction or Lack of Satisfaction.—The dissatisfaction is due to the presence of some stimulus which causes a dissatisfying response. So a pin-prick, the charge of a bellowing bull, or the lesson only half-finished at midnight, cause pain, fear, or fatigue, as the case may be, which are all dissatisfying and from which one tends to escape. On the other hand the want may arise because some stimulus is absent which would lead to a satisfactory response. Examples are lack of food when hungry; lack of opportunity to sleep when tired, lack of opportunity to move about (as in school), when ready to move. When man wants, he is experiencing a stimulus that is causing a dissatisfying response, or is not experiencing a stimulus that would cause a satisfying response.

Because wants are not constant, but fluctuating, we have the phenomenon that a given stimulus may produce satisfaction at one time and dissatisfaction at another time. The triangular relation between *want* and *stimulus* and the result in *satisfaction* or *dissatisfaction* is generally called *readiness*, meaning that a system of bonds is or is not ready to react. We have already seen how the system of bonds representing the want to breathe or eat may be aroused to readiness. Four combinations are possible:—

1. Want is ready	Stimulus present and response follows	Satisfaction
2. Want is ready	Stimulus not present or response prevented	Dissatisfaction
3. Want not ready	Stimulus present and response forced	Dissatisfaction
4. Want not ready	Stimulus not present or response not forced	Satisfaction

The dissatisfaction in (2) is different from that in (3). In (2) we have really a lack of satisfaction. This is essentially a vague, general restlessness, or irritability. Often the individual has no idea as to the cause of his trouble. *Wanderlust* is one name for this sort of dissatisfaction, due commonly to the non-functioning of the sex instinct. Similarly, one often sees a person become more and more irritable without his knowing why, when all that is the matter is that, due to an emergency, he has forgotten his lunch. Much of the unrest of the world to-day is due to the inability of men and women to act as their instinctive natures urge. This fact has become so plain lately that it does not take a psychologist to prophesy that profound changes in our social and industrial organization must be accomplished if individuals are not to be deprived of many of the satisfactions that come through the proper functioning of their instincts.

The dissatisfaction in (3) on the other hand, is specific and directed at the stimulus or the person that is forcing action. So when the mother asks an unwilling daughter to wash the dishes or an unwilling son to tend the furnace, the dissatisfaction focuses upon the mother and on the dish-washing or the furnace, as the case may be.

The equation in (4) is probably only another way of expressing (1). A man who is tired and has seated himself in a Morris-chair with cigar and newspaper for a quiet evening, and then hears his wife discussing the need of buying coffee for breakfast and asking her son to go out for it, feels satisfaction at not being forced to go. But his satisfaction probably arises from being permitted to do what he wants to do, i. e., rest, smoke, and read, and also from being able to escape the dissatisfaction of being forced to do what he does not want to do (Case 3).

The law of effect (discussed in Lesson 15) is undoubtedly related to satisfaction and dissatisfaction, as discussed here. In learning, one keeps on until he secures satisfaction and escapes from dissatisfaction. And in some way those efforts which bring satisfaction are retained better than other repetitions leading to dissatisfaction.

A Want is Essentially a Tendency to Make a Certain Response. Popularly we say, "I want some water," and "I want a bathing suit." We view the object as the want. This is partly true. The object must be present in order to satisfy the want.

But the object is only a means to an end. What is really wanted is the elimination of thirst or the enjoyment that comes from being in the lake. The object is wanted only so long as the want exists. After drinking one does not want water; in the winter time one does not want a bathing suit. It is not easy to accept this conception just because all our lives we have been concentrating on getting things and have not considered the real want that lies back of the interest of the object. Observation of oneself and others will, however, convince one sooner or later that this is true.

A Want Represents Stirred-up Energy.—Any living organism contains a large amount of stored-up (potential) energy. A stimulus causes some of this potential energy to be converted into kinetic (stirred-up) energy, which constitutes the nervous current and causes the muscular response. In the case of reflex action the response normally follows immediately after the stimulus is experienced. But in some cases the response is inhibited, as in the case of not coughing in church, holding onto a hot test-tube in chemistry laboratory, not hitting at a mosquito when stalking a deer. Inhibiting these reflex responses results in accumulating more and more energy to force the reflex response. And as we all know, despite our best efforts, we often finally have to cough or drop the test-tube. The term want can hardly be applied to reflex action when the response immediately follows. But it can truly be applied to those cases where reflex action is inhibited. In the examples above, one wants to cough and one wants not to, due to the arousal of two different mental sets. Whichever set calls forth the greater amount of energy wins. A want is then symptomatic of stirred-up energy.

The case of habitual action is similar to that of reflex action. The stimulus sets off the action, with no particular want present. But if the action is interfered with, more energy is released and a want to perform the action appears. This is the underlying explanation of Tom Sawyer's success in getting the other boys to whitewash his fence. So also, when the teacher asks for the capitals of the three Pacific Coast States, those children who start to answer and may not because they are not called on, immediately want still more to answer, and wave their arms more and more violently.

The fact that a want represents stirred-up energy is best illus-

trated in the case of instinctive behavior. The shrieks of a baby cause its mother to start running instantly. Here the parental instinct is aroused and a large amount of potential energy is transformed into kinetic. In addition, the emotional mechanism (to be discussed later) is aroused and in a few seconds, the whole organism is surcharged with stirred-up energy. One may not be conscious of the stirred-up state if a large amount of physical activity follows, but if the whole situation is cleared up suddenly, then one is conscious of the wave after wave of emotional excitement that sweeps over him.

When an individual wants then, there is stirred-up energy tending to work itself out in action. And the stronger the want, the more kinetic energy is present. This energy enables the individual to exert himself to a degree not possible when he is "cool," and to continue doing so for a surprisingly long time. Consider what soldiers accomplished under fire and what a mother does in tending a sick child! This excess energy often forces an individual to act in obedience to his wants rather than to his better judgment. And finally this excess energy causes random movements, so that if one response proves not effective, others are tried in rapid succession. Herein lies the starting-point of many acquired habits.

A Want is Accompanied by Interest.—A response in some cases is interesting, as in eating or in sheer enjoyment of activity. But what is interesting is not the response, but the stimulus to which one is responding. In putting out a fire in a bedroom, one is interested in the fire and in the objects about it; one is not even conscious of much that one is doing and later cannot explain how he did certain things. Clearly, objects, people, and subject-matter are or are not interesting to us according as they do or do not serve as stimuli which make possible those responses we want to make. *Interest* is an expression of a want.

WANT
STIMULUS > BOND-RESPONSE

So far the formula "Situation-Bond-Response" has served us very well. The term situation has included both the stimulus that is affecting the individual and the sum total of what is mentally present at that moment. From now on, it will be necessary to distinguish the want, or wants, that are present, from

the other elements in the total situation. And it will also be necessary to distinguish between the external stimulus and the inner elements that are brought to mind by the stimulus or were present when the stimulus was encountered. These latter inner elements may be referred to by the term "experience," instead of "bond," if it be borne in mind that the term does not refer to all past experiences, but only to those that have been aroused and are active at the moment. Let us now see what this formula means. Four combinations are possible:—

1. Want absent	Stimulus responded to
2. Want present	Stimulus responded to
3. Want absent	Stimulus not responded to
4. Want present	Stimulus not present but sought for

1. Want Absent—Stimulus Responded To.—If the stimulus is strong enough, or of a certain sort, it will force a response regardless of the other elements. So a sudden pain, or a loud noise, "breaks in" upon whatever we are doing, and we respond by getting away from the pain-producing object or by jumping at the noise. Such stimuli are distractions; they usually set off some sort of reflex action; they cause what is technically known as *involuntary attention*, i. e., we attend, whether we want to or not.

In the above cases, we get the feeling of having had an outside stimulus force its way in and interfere with what we wanted to do. There are, on the other hand, other examples of stimuli which are reacted to when no particular want is present, where the feeling of being forced is absent, or almost absent. For example, while traveling in a train we read the sign-boards as seen from the windows. Responses to these advertisements are due to our habit of reading. So thoroughly has the habit been established that it operates if stimuli are encountered and if not interfered with by any want that is dominating mental activity. Though we do respond in this way to many stimuli which do not fit into our wants, it will be observed that little or no impression is made upon the brain. Desultory looking or reading is most inefficient.

2. Want Present—Stimulus Responded To.—If a stimulus is present that will lead to a response which satisfies the want, the stimulus is noticed with *interest* and responded to. (This case

is spoken of as *spontaneous attention.*) A boy with a hobby for collecting stamps sees stamps wherever he goes; a mother hears the cries of her child when no one else does; a hungry child can smell doughnuts a surprising distance away. Of course, in such cases one notices the stimulus because of habits that have been developed to do so. But these habits were developed because of a want. If the want dies out the person will cease noticing to a considerable extent, but not entirely, because the habit will continue to function somewhat. For convenience, stimuli that satisfy wants will be called *prepotent stimuli.*

3. Want Absent—Stimulus Not Responded To.—If the stimulus is not strong enough to force a response (as in 1) and there is no want present which will be satisfied through a response to the stimulus, the stimulus will ordinarily be ignored. For example, if Smith is planning to debate a certain question, everything that concerns the topic "jumps right at him" wherever he is (example of 2), but he would never notice these items if he did not want to discuss the question. A bird-lover sees and hears every bird in the woods; the average man does neither, for he does not want to, to begin with, and second, he cannot see nor hear much because he has not trained himself to do so. In terms of our formula, there is no response because (1) the stimulus of a bird's chirp is not strong enough to force a response, (2) there is no want to respond to it, and (3) there is no past experience (bond) that connects the chirp with a response of any sort.

In everyday life we ignore nearly all stimuli that do not force themselves upon us or do not tend to satisfy the wants that are present. In other words, we do not observe what we are not interested in. This statement is difficult to believe at first. It is so because we have no idea at all of what we have ignored. The best way to get some comprehension of what you, the reader, are missing, is to go around with a variety of experts and ascertain what they see and hear which you would not notice. In the schoolroom the teacher is constantly forcing certain stimuli upon the child and making him respond to them; but, as we have already seen, unless there is a want to learn, on the part of the pupil, very little results from these efforts of the teacher.

4. Want Present—Stimulus Not Present but Sought For.—If there is a want and there are not stimuli present to satisfy

the want, then the organism becomes more and more restless and uneasy and finally commences to move about and hunt for an appropriate prepotent stimulus. This we see clearly illustrated in the case of hunger or thirst (want to eat or drink). As these wants increase in strength, the person first becomes restless without knowing what is wrong, then gets up and hunts for food or water. As food or drink is always found quite easily in civilized life today, we have no opportunity to witness or experience the extreme struggles that the organism will make to secure satisfaction of these wants before final exhaustion intervenes. But anyone can experiment with the want for air to breathe. Hold your nose and keep the mouth shut. For a few seconds all is well. But the want increases, and finally it dominates every other activity, and you open your mouth and let go your nose. Then you are conscious of the sweet satisfaction of responding to a prepotent stimulus.

A word should be added at this point about our "bond" component in the formula. Through learning, new bonds are formed. Consequently a stimulus that originally caused crying may later cause us to get up, go to the bathroom, and put iodine on a scratched finger. Or the olive, to which our original response was to spit it out of the mouth, is now eagerly sought for and eaten. Or, the activity of shouting louder than the other boys and girls in order to get attention may in time be eliminated and in its place may develop a great interest in winning Phi Beta Kappa.

Relation of Formula to the Three Factors: Heredity, Environment, and Training.—Roughly speaking, the three factors *heredity*, *environment*, and *training* are typified in the formula by the elements *want*, *stimulus*, and *bond*. Our wants and the mechanisms by which they are to be satisfied constitute in a general way the effect of heredity, the stimuli that are encountered make up the environment, and our experiences (acquired bonds) are of course the effect of training. If our wants are few or feeble, we shall make little exertion and so not amount to much. If our environment does not contain the stimuli needed to satisfy our wants, then we shall be badly handicapped; for example, growing up in a neighborhood where good schools are not available prevents the wants from being satisfied in terms of wider and wider experiences. And if broad experience is not developed,

due to the interaction of wants and stimuli, the individual acts largely in terms of immediate satisfactions instead of future satisfactions.

Relation of Formula to the Process of Reasoning.—In Lessons 38 and 39, where the problem of how one solves difficulties is considered, we shall see that difficulties are solved because of some want, because of the presence of some dissatisfying condition, or because of the lack of some satisfaction. Thus the child gets his lesson because, until he does, he lacks the satisfaction that comes with approval; or he hits on a short-cut in order to decrease the dissatisfaction of doing what he does not want to do. Let us recognize very clearly that the cause of solving a difficulty—indeed, the cause of the difficulty's *being* a difficulty—lies primarily within the individual, so that the cause must be expressed in terms of his wants. Dewey's[1] figure of a forked road has been misinterpreted. Unless one wants to go somewhere in particular, the forked road is not a difficulty; either fork will do for a pleasure ride. The first stage in solving a difficulty is always within the individual: it can be expressed as some lack of a satisfaction or as some dissatisfaction. He wants food or wants to escape the cold. With such a want present, he starts out to find a stimulus which will bring about a satisfactory response, i. e., food that he can eat, or a fire, clothing, a warm room, bedclothes, or what not, which will bring him warmth.

[1] J. Dewey, *How We Think*, 1910.

LESSON 32

WHY ONE BEHAVES AS HE DOES (continued)

In this lesson we shall attempt a more detailed analysis of some of the facts and principles enunciated in the preceding lesson.

Why does a person behave as he does? Why does a person respond to this stimulus and ignore that one?

Problem: Why does an individual behave as he does?

Procedure: *Part* 1.—Answer the following questions:—

1. Why do you attempt to solve this assignment? (After writing the answer to this question, ask the question: Why is this answer an explanation of why I attempt to solve this assignment? Record your answer and again test the answer with another "why." Keep on asking "why" until you are sure you have traced back the explanation of why you do this assignment to statements that are final and irreducible, i. e., cannot be explained in terms of anything else.)

2. Why didn't you give these final irreducible statements right off at the start? (Is it because they are too personal, or not very complimentary to yourself, or is it because of other reasons?)

Part 2. Give as good an answer as you can to the following questions from Lesson 1, dealing with Dr. Linder and Cargill. (Test out each question by asking "why" to it, to make sure you have reduced your explanation to final, irreducible statements.)

1. Why should a crowd become angry because a dog had been killed?

2. Would Cargill if he had been alone, have become as angry as he did when surrounded by a crowd?

3. Why did the crowd think Dr. Linder had a gun?

4. Why did Cargill want the Doctor arrested?

Part 3. Arrange the following items in the order in which you, yourself, would prefer to do them. Consider here not what you *ought* to do but what you would like to do.

(*a*) To look at a sunset
(*b*) To eat turkey when hungry
(*c*) To cry when you stub your toe good and hard
(*d*) To comb your hair in the morning
(*e*) To go to college (or normal school, as the case may be)
(*f*) To teach school
(*g*) To hunt partridges
(*h*) To go to church
(*i*) To escape from an infuriated bull
(*j*) To watch two boys, evenly matched, fighting
(*k*) To play with a baby
(*l*) To go to a football game
(*m*) To play tennis
(*n*) To be in a crowd
(*o*) To do this assignment
(*p*) To get up in the morning
(*q*) To have people show their approval of your actions
(*r*) To be the recipient of attentions from one of the opposite sex to whom you are attracted
(*s*) To black your shoes
(*t*) To keep your bureau drawer in a tidy condition
(*u*) To wear good clothes
(*v*) To advertise a twenty-dollar bill you have found
(*w*) To have people looking at you in a scornful manner
(*x*) To stay at home and take care of a sick aunt instead of going to a party
(*y*) To secure a better grade in an examination than another person whom you dislike.

Compare your order with that of your partner. What deductions can you make as to what you naturally like to do and naturally do not like to do? For example, is there any relation between your order of preferences and an order which might be made showing what an ape does and does not do?

Part 4. Summarize and list all the wants encountered in this lesson which you believe are irreducible explanations of why a person behaves as he does.

Part 5.—Are the "irreducible statements" obtained in Parts 1 and 2 "wants or "needs" or both? (Refer to Lesson 31 for explanation of these terms.)

LESSON 33

FUNDAMENTAL INDIVIDUAL WANTS

In attempting to answer the questions in Lesson 32 we obtain two kinds of answers. In one kind, a reason is expressed; in the other kind no reason is given, but the verb "want" appears. For example, in answer to the question "Why do you attempt to solve this assignment?" one may give the reply "Because it has to be done to pass the course." When asked, "Why do you want to pass the course?" another reason may be given, to the effect, perhaps, that it is required for a degree or a certificate. Again a "why" may be asked. And so it may continue until one is replying that he wants to eat, to keep warm, to sleep, to be independent, and to be looked up to with respect, etc. The "why" for working out the assignment is finally expressed in terms of fundamental wants.

These fundamental *wants* represent *innate modes* of behavior that have not been learned. The *reasons* represent *learned modes* of behavior. "I want to eat when hungry"—that is native. But the "want to eat oysters" is acquired; that is, the specific taste for oysters is acquired. So when you ask why I want to eat oysters, I can explain my desire by saying, "I want to eat." But I cannot explain the want to eat. (The need of eating can, of course, be explained in terms of preservation of life, but we must sharply distinguish here between wanting a thing because it is satisfying and needing it because it is essential.

Fundamental Characteristics of Living Organisms

Protoplasm has five principal characteristics: (1) *sensitivity*, (2) *conduction*, (3) *movement*, (4) *nutrition*, and (5) *reproduction*. Stimuli irritate all forms of life; this irritability is conducted to other parts of the organism; and the organism moves towards or away from the stimulating object. It "eats" certain of these objects, thereby growing new tissue or replacing worn-out tissue. The crucial test of living material is reproduction. In man, these

five characteristics are to a large extent differentiated, so that sensitivity is restricted primarily to the sense-organs, conduction to the nervous system, movement to the muscles, nutrition to the digestive system, and reproduction to the sex organs. With specialization most of the cells in the body have given up their five characteristics; but some, like the white corpuscles, have remained similar to the unicellular form. Moreover, stimulation of any part tends to affect the entire organism; activity of the nervous system similarly tends to affect every part; any movement tends to have the same effect; the same is true of nutrition and reproduction.

We may postulate a sixth characteristic about human beings and possibly about some animals. That is *consciousness*. I know that I am conscious. I infer that my friends are also conscious. With less certainty I infer that my dog and cat have some sort of consciousness. But there is no way of proving these inferences.

It is the physiologist, not the psychologist, who is interested in the five fundamental characteristics of protoplasm, as such. The psychologist is interested in combinations of the first three— sensitivity, conduction, and movement in which consciousness is more or less involved. Hence the formula *situation, bond, response*, emphasizing movement because of stimulated sense-organs. Such combinations make up behavior.

The wants of man come, however, very largely from these six characteristics. Very fundamentally, man wants stimuli to be affecting him; he wants mental activity (conduction) although he is often satisfied with far less than a teacher desires; he wants to move about, be active at times; he wants to eat; and he wants to mate. Furthermore, he wants these as conscious processes. One does not want music played while he is unconscious; nor to talk nor walk in his sleep; nor to have food fed to him while he is under the effect of drugs. Man's wants all find expression in conscious activity.

Let us turn, now, and consider more specifically what are the wants that man desires to have satisfied. Answering this question takes us into a field of psychology in which much has been written but in which very little is known in a scientific sense. Consequently, what is recorded here is very largely the opinion of authorities in this field; how much of it is truly correct remains

for future investigators to determine. But the topic is probably the most important one in psychology, and therefore the best information that is available must be used until better information is at hand.[1]

Man's Fundamental Individual Wants

1. Sensory Impressions.—Man wants to have stimulation coming in steadily through his sense-organs. If he is not looking at something, he must be listening, or smelling, or tasting, or feeling; otherwise he will grow restless and dissatisfied. So colors, moving objects, music, rhythm, and objects touching the skin are desired. (Certain stimulations are not desired, such as excessive heat or cold, or pain, or bugs crawling on the skin, etc.) He has also certain sense-organs within his body that are concerned with orientation, movement of the muscles, and visceral activities. As a child, at least, he enjoys being slightly dizzy, swinging, etc. Conscious sensations from the viscera all seem to be unpleasant. It is worth noting however, that general well-being, buoyancy, or "pep" is probably the resultant of normal activity of these visceral sense-organs as they report to the brain. Much of the enjoyment of riding in an automobile, dancing,

[1] An instinct, technically speaking, should be viewed as a specific mode of behavior, due to an innate bond connecting sense-organ with muscle. Apparently, all such are so relatively simple that some have been tempted to deny the existence of instincts as distinct from reflexes; in other words, to reduce the expression "eating instinct" to many reflexes, such as "suckling," "swallowing," "licking the lips," "spitting out," etc. Inasmuch as man must group items into larger wholes for convenience in thinking, it seems worth while to keep the term "instinct," even though further experimentation should finally prove that there are no instincts in a strict sense, but only reflexes that sometimes do and sometimes do not operate in functionally larger units. There are apparently other types of native behavior which are hardly to be explained in terms of the existence of an innate bond. Such is the case of resistance to interference; this mode of behavior in its native aspect is due to the discharge of more and more energy as resistance is encountered.

The term "want" is employed here because the writer believes it to be a concept that students can more quickly come to use than "instinct." To the writer a want expresses fundamentally a lack of chemical equilibrium. The want to breathe, to eat, to mate and to resist, are due to chemical changes. Possibly when more is known about internal glands, etc., the want to lead or to be submissive may similarly be expressed.

swimming, etc., is due to the satisfaction of receiving a steady stream of sensory impressions.

Man further wants variety and change in his sensory stimulation. Constant repetition is nearly always annoying. Moving objects and changing sounds are consequently much more satisfying than others. To certain changes in stimulation, such as a loud noise or a moving object, man has reflexes whereby he jumps in the first case and turns to look in the second.

2. Curiosity.—Man wants not only a steady stream of incoming sensations, but also a certain amount of mental activity going on, whereby these incoming sensations are elaborated into various combinations. This is hardly a conscious want, but is manifested in the constant shifting of attention from this to that. What is meant by curiosity seems to the writer to be a phase of this necessity for shifting, wherein the individual becomes quite conscious that he has shifted to something that is holding him in an unusual way. And this something that arouses curiosity is a *new combination* of *old familiar things*. McDougall expresses the same idea when he says that the situation which arouses curiosity "would seem to be any object similar to, yet perceptibly different from, familiar objects habitually noticed."[1] To a new thing we have no response; so we ignore it. To an old familiar thing we have such a well-formed response that we hardly note that we are responding at all. But in the case of an object which arouses old responses in *a new combination* we tend to respond freely to the parts, and at the same time slowly and hesitantly to the new combination. (See Lesson 15 for illustrations and applications to teaching.)

The term "visual exploration" refers to the continual shifting of the eyes from one point to another, thus producing a continual shifting of conscious impressions. Curiosity is a special phase of this more general want of man. Out of these simple processes arise the more intellectual wants—to combine ideas together in day-dreams or to explain what is being experienced in terms of what has been experienced. The highest activities of man's mind, such as inventing and scientific thinking are developments of these simpler wants.

3. Activity.—Not only does man want activity of sense-organs, and of the central nervous system involved in elaborating

[1] W. McDougall, *Social Psychology*, 1908, p. 60.

incoming impressions into objects (percepts), ideas, and causal relations; but he wants also to be constantly moving, i. e., responding to situations. Apparently far more energy is generated than is needed, particularly in youth, and this energy has to be used up. Hence, activity, exercise, play, operation of the vocal cords, etc., are desired. For a child, to be compelled to be quiet is punishment, and indeed it is an impossibility except for brief periods of time. Smoking, chewing, knitting, whistling, talking, etc., are ways in which adults use up this energy.

Trial-and-error learning is possible just because man is ceaselessly doing one thing and then another and at the same time receiving stimulations. Combinations that are satisfying, in the sense of satisfying some want, are selected and repeated, whereas those that bring no satisfaction or positive dissatisfaction are abandoned.

Merriment, sport, joy, and humor are not well understood. They all represent wants. Whether they are original, simple wants or compounds is a matter of discussion. It would seem that basically they are expressions of activity.

Imitation refers to the doing of that which another is doing. Because of man's want to be active, he is doing something all the time. When he notices an action of another, it becomes a part of the total situation affecting him and consequently his next act is in terms of it, particularly if he has no other act that he wants to perform at the moment. Whether his imitating action will be a real copy of what has just been seen, or something quite different, depends on a number of factors that will be considered in Lessons 40 and 41.

4. Readiness.—The principle of readiness has been explained in Lesson 31. It represents a very general and fundamental condition. At certain times a stimulus-bond-response combination is ready to act; at other times it is not. When it is ready to act, man wants it to act, and when it does he is satisfied: When it is not ready to act, man does not want it to act, and if he is forced to act, he is dissatisfied. He is also dissatisfied if a combination is ready to act and is prevented from doing so.

When man is ready to act and is stopped, he experiences "suspense" which ripens into annoyance, irritability, and sometimes anger. Thinking is always the inhibiting of activity, for it involves waiting while ideas or experiences are reviewed and

tested out as to their applicability to the difficulty confronting the individual. Thinking has always, then, an element of dissatisfaction connected with it. It is always work as distinguished from play, in which latter we are acting with a minimum of control. One of our most valuable mental processes is that of *inhibition*, the ability to check an impulse. Moral conduct and intellectual power cannot be developed without it, for both depend on checking the first impulse to act until after the consequences can be evaluated and other possible responses carefully weighed.

Worry is experienced when we are inhibited from carrying out some action involving instinctive behavior. We feel the pent-up emotion which would otherwise discharge through the instinctive activity. For example, we feel suspense when waiting for a street-car. But we worry when the street-car ride is necessary to get us to the bedside of our sick child.

That one of man's strongest wants is to escape from suspense and worry explains why he plunges ahead instead of thinking any further, or even of stopping to think at all.

5. Eating.—Man must eat and drink to keep alive. He is geared up natively to suck and swallow, and later to pick up objects and put them in his mouth. When he experiences certain tastes he eats and swallows; with certain other tastes he spits out what he has in his mouth. If he gets something into his stomach that does not agree with him, it is vomited up. As he grows older he learns also how to use vision and smell rather than just taste alone in distinguishing what to put in his mouth and what not to. But taste always remains the final arbiter of what is good to eat. Man has no original, nor easily acquired, interest in a balanced ration: He eats what he wants to. Usually what he wants is good, but he will eat some poisons very readily. Moreover, he often keeps on eating foods which he knows are bad for him, until serious consequences result.

6. Hunting.—Probably an outgrowth of the reflex of putting objects in the mouth is the hunting instinct by which man pursues with enthusiasm small escaping animals and objects, catching them and dismembering them. The "want" here is primarily to pursue and catch, but there is also probably some native desire to possess the object after it is caught. Thorndike[1] aptly explains how this instinct, so necessary to man in the savage state,

[1] E. L. Thorndike, *Educational Psychology*, 1913, Vol. I.

becomes twisted and warped under civilized conditions. He says: "The presence of this tendency in man's nature under the conditions of civilized life gets him little food and much trouble. There being no wild animals to pursue, catch, and torment into submission or death, household pets, young and timid children, or even aunts, governesses, or nursemaids, if sufficiently yielding, provoke the responses from the young. The older indulge the propensity at great cost of time and money in hunting beasts, or at still greater cost of mankind in hounding Quakers, abolitionists, Jews, Chinamen, scabs, prophets, or suffragettes of the non-militant variety. Teasing, bullying, cruelty, are thus in part the results of one of Nature's means of providing self and family with food; and what grew up as a pillar of human self-support has become so extravagant a luxury as to be almost a vice."

7. Acquisition, Possession, Collecting (Hoarding).—Whether there are native "wants" to acquire objects, keep them, and hoard certain of them, is questionable. The squirrel undoubtedly has all these; the dog also, save that he buries his bones separately and not all together. There is no question that man acquires these traits very easily, if he does not have them natively. Thorndike describes them as follows:

"To any not too large object which attracts attention and does not possess repelling or frightening features, the original response is approach, or, if the child is within reaching distance, reaching, touching, and grasping. An object having been grasped, its possession may provoke the response of putting it in the mouth, or of general manipulation, or both. The sight of another human being going for the object or busied with it strengthens the tendencies toward possession. To resistance the response is pulling and twisting the object and pushing away whoever or whatever is in touch with it. Failure to get nearer, when one has moved toward such an object of attention, and failure to grasp it when one reaches for it, provoke annoyance, more vigorous responses of the same sort as before, and the neutral action which produces an emotion which is the primitive form of desire."[1]

"There is originally," in addition, "a blind tendency to take portable objects which attract attention and carry them to one's habitation. There is the further response of satisfaction at contemplating and figuring them there. These tendencies

[1] E. L. Thorndike, *op. cit.*, p. 53.

commonly crystallize into habits of collecting and storing certain sorts of objects whose possession has additional advantages . . . Thus, money, marbles, strings, shells, cigar tags, and picture postals become favorite objects by their power in exchange, convenience of carriage, permanent attractiveness, and utility in play. But clear evidences of the original tendency may remain, as in those who feel a craving to gather objects which they know will be a nuisance to them or who cannot bear to diminish hoards which serve no purpose save that of being a hoard."[1]

8. **Vegetative Functions.**—Several wants which pertain to the needs of the body may be mentioned at this point.

Need for air to breathe. If this is interfered with the most desperate struggling will follow.

Need for proper temperature. Man avoids too warm or cold objects and places. Because of this under certain conditions he wants shade or sunshine, a cool breeze, cold water, clothing, shelter.

Freedom from pain and suffering. There exist many reflexes which operate to free the body from pain and in a few cases from threatened injury, as, for example, coughing and sneezing to rid the mouth and throat parts from tickling objects; jerking the limbs away from a painful stimulation; winking to protect the eye; and dodging and warding off blows to protect the head; and so on. It should be emphasized in this connection that there are no native tendencies to avoid many pain-producing situations until after pain has been experienced. So man wants to escape from the effects of ill-health when he feels badly, but he never does anything naturally to keep good health when he has it. All modern medical aids to health must be learned.

Need for rest and sleep when fatigued. Man's want to be active becomes less and less ready as fatigue comes on. Finally he ceases to be active and seeks rest and sleep. The healthy infant or young animal is either active, eating, or asleep. It does not lie still doing nothing. Adult men and women have less excess energy and so respond to fewer miscellaneous stimuli than does the child, and when they respond they do so in a less active manner, unless there is a definite want present to be satisfied. They tend to conserve their energy and come more and more to want those things which save effort. This counter-

[1] E. L. Thorndike, *op. cit.*, p. 53.

tendency to activity, which is distinct from the tendency to rest when fatigued, is called *inertia.*

9. Reactions to Danger.—Watson[1] has studied experimentally the behavior of many small babies. He finds that *fear* is occasioned by the following situations: (*a*) "To suddenly remove from the infant all means of support, as when one drops it from the hands to be caught by an assistant; (*b*) by loud noises; (*c*) occasionally when an infant is just falling asleep or is just ready to waken, a sudden push or a slight shake is an adequate stimulus; and (*d*) when an infant is just falling asleep, occasionally the sudden pulling of the blanket upon which it is lying will produce the fear responses." "The responses are a sudden catching of the breath, clutching randomly with the hands (the grasping reflex invariably appearing when the child is dropped), sudden closing of the eye-lids, puckering of the lips, then crying; in older children possibly flight and hiding (not yet observed by us as 'original' reactions.)" The above appeared at birth. Watson has not found instinctive fear of the dark, nor of snakes, bugs, nor animals. (Just how fear of the dark arises will be discussed in a later section of this lesson.)

Rivers[2] reports four different instinctive responses to a situation producing fear. The first is flight—getting away. Accompanying flight are usually cries of fright. The second is immobility or paralysis. A covey of young partridges shows the latter response most perfectly. It is also seen once in a while when a person suddenly stops still in the middle of traffic after having run back and forth. Accompanying immobility is the suppression of fear and pain, Rivers suggests. A third response is that of aggression, fighting back when attacked, especially when cornered. Ordinarily fighting is accompanied by anger. (As such it will be discussed in the next lesson.) Still a fourth response occurs when no one of the others is effective, or possibly rather when there is a conflict between such responses. Then appears collapse with terror, or in milder form, trembling. "This," Rivers says, "is the penalty man has to pay for the pliancy of his danger-instincts, for their failure to become systematized or fixed in any one direction."

[1] J. B. Watson, *Psychology from the Standpoint of a Behaviorist*, 1919, p. 199ff .

[2] W. H. R. Rivers, *Instinct and the Unconscious*, 1920, p. 52ff.

Rivers reports another form of reaction to danger which he calls "manipulative activity" and says, "it is the normal reaction of the healthy man. In the presence of danger man, in the vast majority of cases, neither flees nor adopts an attitude of aggression, but responds by the special kind of activity, often of a highly complex kind, whereby the danger may be avoided or overcome." For example, "The hunter has to discharge his weapon, perhaps combined with movements which put him into a favorable situation for such an action." It is well to recognize that man does act in just such ways in the face of danger. But it does not seem correct to call this reaction an "instinctive" response to danger. It is really no more than a complex mixture of random movements, habits, and instinctive tendencies to fight or to run away.

The Acquisition of Fears.—The stimuli found by Watson that produce fear seem ridiculously few in number when all the situations which frighten adults are recalled. This leads to one of the most important phases of this lesson. Watson has shown that adult fears can be taught to children very easily, and he maintains that they are learned. The present writer is not yet certain that all are learned. It is possible to suppose that the stimulus, "a large animal approaching," does not naturally arouse fear in infancy, yet might later do so because of some natural change within the individual. No reaction on the part of the baby would serve to protect it anyway, whereas in the case of older children and adults flight would often save life. At the present time we do not know whether the reaction "flight" to the stimulus "mad bull approaching" is native or acquired. But we do know that all would run if faced by such a situation. But—to return to Watson's contention that fears are learned—how does this learning take place?

Watson experimented with a baby that had shown no fear of the dark or of tame animals, such as mice, rabbits, cats, dogs, and pigeons that ran or flew about him, or of wild animals at the Zoo. Then, on another day, after the baby had again shown no fear of rats, Watson presented a white rat and at the same time had a loud noise made. To the latter the child responded with fear. A few minutes later the rat was again presented and the baby reacted with fear to it. And more surprising still, he showed fear of other animals, and even of a false face which Watson put on

his presence. This is merely another example of substitution of stimulus-learning (refer to Lesson 11), i. e.,

$$\begin{tikzcd}
\text{white rat} \arrow[r] \arrow[dr, dotted] & \text{visual exploration} \\
\text{loud noise} \arrow[r] & \text{fear}
\end{tikzcd}$$

But there is a profound difference between learning to react to a new stimulus in an emotional manner and learning to react in some way involving no emotion. In the former case one experience is usually sufficient to connect the new situation with the emotional response so that it may function for years in that way: In the latter case more than one experience is necessary and the new combination can be forgotten or broken up without much difficulty.

We see this substitution in animals as well as man. "If a horse is violently frightened at a certain point on the road by a terrifying object (a rolling paper in one observed case), it may exhibit the fear reaction when again passing over that part of the road, although the terrifying object is no longer present. A shaky bridge will make a sensitive horse terror-stricken, and this will endure long after the bridge has been made of concrete."

10. Emotion.—Some of man's most important wants are of a purely emotional sort; in others emotion is involved as a leading element. To understand these wants we must have some conception of what emotion is.

Nature of Emotion.—Cannon[1] tells us that under the influence of emotion the heart beats more rapidly, the blood pressure rises, and breathing becomes deeper and also more rapid. The blood is driven out of the entire digestive system to the heart, lungs, brain, and muscles through the contraction of the blood vessels in the digestive system, and their dilation, particularly in the muscles. Sweat may break out on the skin, thereby preparing the body for rapid elimination of heat and waste products following excessive muscular activity. Such changes constitute the fundamental basis of an emotion. But the mechanism is even more complicated. There are two small glands, situated near the kidneys, called the adrenal glands. They also are stimulated. And they pour into the blood-stream a chemical called adrenalin. This chemical affects the various internal organs directly and

[1] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, 1915.

in the same way that the nervous system has already done. It stimulates the heart to greater activity; it causes the blood vessels in the stomach and intestines to contract and those in the muscles to dilate; it causes the stored-up sugar in the liver to be poured into the blood and used as fuel for the working muscles; it eliminates consciousness of fatigue and it even goes so far, apparently, as to put the blood in such condition that it will clot more rapidly than usual if the body is wounded.

What we experience when emotionally excited is the sum total of our consciousness of all these bodily changes. And apparently whether we are excited because of fear, rage, or love, our body is prepared for the maximum expenditure of muscular activity.

The above constitutes what might be called the physiological side of emotion; the psychological or conscious side is hardly understood at all. But it is clear that the conscious differences between fear, rage, and love cannot be explained as Cannon has described emotion; there are other elements that must be included.

Emotion can be viewed as a special adaptation of the whole body to make responses, and to do so with the maximum available energy and endurance. Emotion can be likened to the magneto in some types of automobile. It has to be stimulated (cranked), but once started it keeps the whole mechanism going.

Psychologists are not in agreement as to what emotions man has. Watson,[1] for example, maintains that there are only three different emotions—namely, fear, rage, and love. Woodworth[2] speaks of grief, mirth, and other emotions. In addition, McDougall[3] recognizes a somewhat different list: Fear, disgust, wonder, anger, subjection, elation, and tender emotion. The writer will attempt no list of emotions, but simply maintain that with each instinct there is present a stirred-up or emotional state.

How are instinct and emotion related? Suppose you are suddenly attacked. Immediately you fight back, or run away. Here the chief characteristic of behavior is instinctive—either fighting or fleeing. But suppose you wake up and think there

[1] J. B. Watson, *op. cit.*, p. 199.

[2] R. S. Woodworth, *Dynamic Psychology*, 1918, p. 51.

[3] W. McDougall, *Social Psychology*, 1918, Chap. III.

is a burglar near by. You listen and become surcharged with emotion. In the first case you were just as emotionally aroused as in the second case, but you were too occupied with what you were doing to be conscious of it. In the second case, not being active, you are aware of your stirred-up condition. Rivers,[1] writing in this connection says, "Those who escape from danger by the performance of some complex activity bear almost unanimous witness that, while so engaged, they were wholly free from the fear which the danger might have been expected to arouse . . . That the absence of fear is due to suppression of the effect (emotion), which seems to accompany the primitive reaction to danger, is supported by the insensitiveness to pain which often occurs at the same time. Not only may an injury occurring in the presence of danger fail wholly to be perceived, but the pain already present may completely disappear, even if it depends upon definite organic changes."

Emotion is primarily a physiological stirred-up condition by which instinctive responses may be facilitated, and is ordinarily consciously experienced only when the instinctive response is inhibited.

Emotional Wants.—In all of the discussion so far concerning instinctive activities, it has been assumed that emotion is aroused simultaneously. That is the normal course of events. But often the individual is prevented from making the instinctive response. He then becomes "pent-up" with emotion (kinetic energy); he becomes like an anarchist's bomb already to explode. What does he want to do then? Consciously he wants to discharge this pent-up energy, and he does it sooner or later. So the employe who has been "called down" by his boss lets fly at a fellow-employe, or at the newsboy on the street, the conductor on the way home, or the cat on the porch, or he growls at the tough steak for dinner. At least two school teachers in one school, expecting a holiday and suddenly ordered to keep school if half the class attended, made life miserable for the children who did attend, to the utter consternation of the children, who could not understand why they should be denounced for having come to school.

From a hygienic standpoint, when one is in a pent-up condition, physical exercise, like walking, is a very good way of using up

[1] W. H. R. Rivers, *op. cit.*, p. 57.

this excess energy. It is amazing how much brighter the world looks after a good walk. Herein lies one of the best reasons why exercise is good for the young. The person who is pent-up should refrain from eating, for when he is emotionally excited digestion does not take place and the food only sours in the stomach.

The experiencing of emotion is usually pleasant. Even in the case of fear, worry, and other unpleasant emotions, a small degree is enjoyable. Children like to work themselves up over an approaching ragman whom they view as a kidnapper. Much of the enjoyment of reading novels or attending a movie comes from emotional thrills of all sorts. Apparently a great number of people get much of their amusement in this way, i. e., through arousing their emotions and just enjoying them in day-dreams, reading novels, going to revival services, etc. Some of this is very desirable. But too often it results in short-circuiting the emotional activity into perfectly useless channels (aside from the enjoyment of it) and the person does not become the forceful character that he might be. The secret to the success of certain people would seem to be that they have learned to utilize all of their energies along the line of their work, thereby getting much enjoyment in connection with their work and also accomplishing a surprising amount.[1]

Some Practical Applications

Emotional Responses Easily Attached to Situations.—Fear can be attached to any situation if that situation is presented simultaneously with another situation which already arouses fear. Thus, a baby and its mother encounter a spider, the mother screams from terror and the child shows fright. The mother's cry here arouses the baby's fear. The spider has, however, been associated with fear responses and the next time it is seen the child shows fear. Thus do human beings learn to fear, or love, or hate, to show approval or scorn. These reactions govern life far more than do intellectual responses. But today their development is largely left to chance, whereas they should be most carefully handled.

[1] For further discussion see W. James, *Energies of Men*; J. B. Watson, *op. cit.*, p. 214ff; and A. G. Tansley, *The New Psychology*, 1920.

Man's Natural Wants are the Starting Point in Interesting Him and in Building Behavior of Value to Him and to Society.—The presentation of any situation which arouses instinctive or strong habitual responses will attract attention and arouse genuine interest because it will be naturally and pleasurably reacted to. In this course we shall not be able to consider this topic as it deserves. But the student should see to it that he does secure such instruction as an integral part of his preparation for teaching. Let us consider, however, a number of examples of how attention is secured through presenting situations which are connected with instinctive responses.

The whole movement to make schoolroom work play for small children is an example. Anything that is "play" for a child is instinctive or very simply related to the instinctive. The game of throwing at a target and then scoring up the hits is based on many instincts,—love of activity for its own sake, rivalry, securing favorable attention, etc. Incidentally the children learn to count and to know what various combinations of figures mean.

In physical education there has been a very pronounced drift away from regular exercises to plays and games. The teacher has less trouble now than formerly in securing discipline or getting effective work done, because the pupil naturally wants to do just these things. Rearrangement of the work in this department to fit the instinctive life of the pupil has, then, resulted in accomplishing the same aims with far less trouble for the teacher. Undoubtedly, too, the pupils have greatly benefited, because now they enjoy the work whereas formerly a goodly number hated it.

In teaching nature study and other subjects much is often made of the collecting instinct. The collecting of different kinds of leaves, of seed pods, of birds' nests, etc. is most easily brought about by simply suggesting it. The child learns a truly surprising amount of detail in connection with the instinctive performance of collecting and hoarding. Of his own accord, a boyhood friend of the writer carried the collecting tendency over from collecting the objects themselves to making lists of them. He still owns the notebook in which for several years he listed on each date all the birds he saw. The collecting instinct was fundamental to the acquiring of knowledge about the birds in the vicinity.

These instincts can be utilized in almost any course of study in which a large number of very similar objects must be accumulated. Even lists of words with a common stem, as they are accumulated, take on an added interest because of the collecting instinct.

Geography and history courses are steadily being humanized; the lower we go in the school system the truer we find this to be. We can accomplish the same results with far less effort by building our historical or geographical conceptions around the lives of real people than around abstract conceptions. This is because we are instinctively interested in the doings of living beings, animals as well as men. Thus, in a typical present-day primary course, child-life among the old Tree-Dwellers and Cave Men is used as the second-grade history work, and is followed in the third grade by a study of Child-life among Esquimos and Indians. Geography is introduced by showing how children live today in other lands, such as Holland or Japan.

LESSON 34

FUNDAMENTAL SOCIAL WANTS

Man's social wants can be grouped, for convenience, under five main heads according as man is concerned with fighting, with reproduction, with care of offspring, with a group of individuals, and with play.

Resisting Interference—Fighting

Psychologists are not yet in accord as to what are the stimuli that arouse fighting and anger. McDougall[1] contends that there is "no specific object or objects the perception of which constitutes the initial stage of the instinctive process. The condition of its excitement is rather any opposition to the free exercise of any impulse, any obstruction to the activity to which the creature is impelled by any one of the other instincts." He explains the anger aroused by a sudden and unprovoked blow as due to interference with the instinct of self-assertion (discussed below) and defends his case by claiming that one does not become angry over a blow received from an impersonal source. Watson[2] upholds this view when he states that "the hampering of the infants' movements is the factor which apart from all training brings out the movements characterized by rage." Thorndike[3] recognizes in addition to interference the stimulus of sudden pain as a cause of fighting and anger.

In terms of the fighting instinct, we may state that man wants to be let alone at all times, except possibly when he is sick, and then he wants *nursing care.* Man further particularly wants not to be interfered with when engaged in any activity. In other words, when he is ready to react he does not like to be checked. Even such a trivial matter as having another person walk in

[1] W. McDougall, *Social Psychology*, 1918, p. 62.

[2] J. B. Watson, *Psychology from the Standpoint of a Behaviorist*, 1919, p. 200.

[3] E. L. Thorndike, *Educational Psychology*, 1913, Vol. I, p. 68ff.

front of one so that one has to slow up a little causes irritation and annoyance.

If the interfering individual appears to be not too inferior in fighting qualities, the response is anger and fighting back; while if he appears to be decidedly inferior, the response is more irritation than anger and a mastering rather than a fighting attitude is assumed (discussed below). If he gives the impression of being equal or slightly superior, the response of rivalry results; and if he is clearly superior, submissiveness results, unless overt attack is experienced, in which case the response is flight and fear, or—if flight is impossible—defensive fighting.

Some of the most deplorable aspects of behavior result from the fighting instinct. Jealousy is due to interference (as with one's loved one) when attack is not possible. Resentment, hatred and revenge arise when one is interfered with and cannot fight back, because of physical inferiority, or because some other advantage may be lost if an attack is made. Thus, we resent much more the interfering actions of a superior in business whom we *could* defeat in a fist-fight than we do those of a superior whom we *could not* possibly defeat.

Sex Instinct

Watson[1] finds that "stroking or manipulation of some erogenous zone, tickling, shaking, gentle rocking, patting, and turning upon the stomach across the attendant's knee" are the situations producing love-responses in babies. "The response varies. If the infant is crying, crying ceases, a smile may appear, attempts at gurgling, cooing, and finally, in slightly older children, the extension of the arms, which we should class as the forerunner of the embrace of adults." All this is far-removed from what is understood as sex behavior. Whether all the difference is acquired from experience, or whether part is due to the later development of the sexual and other internal glands of the body is not known.

Observation of adults suggests very strongly that the sex instinct must be considered in terms of two levels—the purely physical level and the psychical level. This psychical level pertains to the mental relations between individuals of the opposite sex who are in love. Courting and the everyday life of husband and wife are on this level. In addition, another center of inter-

[1] J. B. Watson, *op. cit.*, p. 201.

est can be postulated, involving the parental instinct, in which the sex instinct is expressed through the parents' care and protection of the offspring. All evidence points to the conclusion that a full and happy life requires interrelations between husband and wife on the basis of all three of these interests.[1]

In the very brief space here available it is impossible to even attempt to cover this subject. But one other characteristic of instinctive activities needs attention and can very well be illustrated in terms of this particular instinct. An individual may be very vitally interested in the *stimulus* that is arousing him, or the *emotion* that he is experiencing, or the *response* he is making, but he is seldom aware of all three phases at the same time. And still more important, he is not aware that because of the stimulus he is really forced to do what he finds himself doing, or to feel as he finds himself feeling. That is, the compulsive nature of the instinctive mechanism is seldom consciously realized—the instinct is hardly comprehended as such. Unless the adolescent comes in contact with others of his own age of both sexes and enjoys their company and their games and amusements, including a wholesome amount of flirting, the sex instinct remains very largely an unknown force and pretty much beyond conscious control. Most of us can give illustrations of this drawn from the lives of our acquaintances. Several persons have come under the writer's notice who were deprived of ordinary adolescent social life, and who have never been able to adjust themselves, even when they had made apparently suitable marriages. The problems arising when youth becomes acquainted with its instinctive tendencies, especially those of sex, are among the most serious that confront parents, educators, and those interested in social welfare.

Because of social restrictions the sex instinct is more often inhibited when ready to function than any other. For this reason it is the cause of much of the unrest of the world. And surprisingly often the individual is unaware of the cause of his restlessness. The restlessness becomes attached to situations that occur at the time, just as fear occasioned by a loud noise becomes attached to a mouse or spider or the dark. Because of this the celibate person has the "blues" from time to time, shows dissatisfaction with what he is doing, wants to try something else. But

[1] A. G. Tansley, *The New Psychology*, 1920.

no change will alleviate his unrest. It is the price youth has to pay for prolonging the period of preparation for life.

Parental Instinct

The stimulus that arouses the parental instinct is the baby and particularly the cries, gestures, and movements of the baby. The most potent of all is the cry of distress or pain. But expressions on the baby's face, interpreted by adults as satisfaction or dissatisfaction, are also stimuli. The responses are to notice, get hold of, fondle and nurse the baby, also to show delight in owning it, pleasure at its expressions of happiness and concern over its expressions of unhappiness and distress. Part of the instinctive response is a general tendency to do things that will cause the child to show delight and cease its cries. The emotion accompanying this instinct has been called "tender emotion" by McDougall for the lack of a better term.

These responses are best exhibited by the mother toward her own child; but they are fairly well shown by nearly all women and even girls and by men and boys. Some women do not show so much tender emotion as many writers would have us believe, even toward their first-born. As time goes on, however, the full strength of the instinct often develops. Men, even fathers, show much less of this instinct than women, but they respond to babies to some extent, particularly in feeding, protecting, and playing with them.

The instinct becomes modified very easily in some directions. The mother picks up surprisingly quickly the approved ways of handling the child. It is modified not only by the acquisition of new responses but also by the addition of new stimuli. Any child will arouse it as does one's own. (Undoubtedly herein lies woman's objection to fighting among boys—their cries make her uncomfortable; she must do something to change the cries of distress into those of pleasure, or at least to stop them.) The instinct becomes similarly aroused by the young of any species. Even baby mice are tenderly reacted to by a woman who hates grown mice; she finds it difficult to dispatch them. In many women there is an inordinate interest in small things, suggesting that "smallness" in general arouses the instinct; very small articles are called "cute" or "ducky." This instinct is also

aroused, but among a fewer number, by suffering in adult men and women and adult animals. McDougall[1] feels that the emotion aroused in such cases may be tender emotion but that more usually it is rather the complex emotion of pity—pity being made up of tender emotion and sympathetic pain. By this is meant that the sight of a wretched looking blind man makes us put ourselves in his place and imagine his feelings, which to us are unpleasant. According to the relative strength of our pain or tenderness we hurry by, wishing "they wouldn't allow such people in public places," or we buy a pencil or possibly help him in some other way. A well-dressed blind man arouses some pity, but much more tender emotion, so that nearly everyone will help him across the street, whereas many people find it difficult to help the beggar, although they would like to.

The great strength of the parental instinct leads to many actions that are undesirable. Relatively few women can force themselves to bring up a child on a regular regimen because they cannot refrain from violating their own rules when the child cries. And there are not many (speaking from my own observation), who, when entertaining a neighbor's child, will comply with the parent's request not to feed it as it is not feeling well. "Just a little candy won't do any harm," is the defense. The real cause is that there is too great satisfaction in feeding a child to permit of its being inhibited by admonitions from the child's mother. It is easy today to arouse public opinion because of suffering. But it is extremely difficult to secure help in correcting the conditions that cause the suffering, particularly if the two are not clearly associated. The same situation holds true with respect to a parent's attitude toward the child's health. Many parents will calmly refuse to do anything for a child who is developing trachoma, although they are thoroughly warned. But later when they themselves can see the child's sore eyes and realize his defective vision, they will spend money freely and show the greatest agitation. Because of the strength of the instinct, women would tie their children to their apron strings, if it were not that most children are active enough to escape. Yet woman admires the brave and despises the coward. Only a mother can comprehend the struggle that goes on in mothers' hearts when war is declared, and women have to decide between protecting

[1] W. McDougall, *Social Psychology*, 1918, p. 77.

their boys and letting them do their duty. The marvel is that so many women quit themselves as heroes.

Filial Love.—Most writers maintain that on the part of children towards their parents there is no instinctive response corresponding to the parental instinct. Children do have the parental instinct itself, though in weaker form, showing it towards dogs, cats, and dolls. This sentiment they show in some degree toward their parents. But they have relatively less opportunity because the parent does not often satisfy the ideal situation arousing this instinct, not being small, helpless, nor given to crying. Children show love most when the mother breaks down and cries, or when either parent is sick or in distress. If parents would have their children love them not only in childhood but in after life they must provide opportunities whereby the child will begin serving them early in life and continue doing so as they grow older.

Woodworth[1] suggests that there is a filial instinct to "take from" the parents, in contradistinction to the parental instinct to "give to" the child. If so, it is not unnatural for the child to impose on the mother in a way in which the mother cannot act toward the child. This suggests that possibly the want for *nursing care* which children and even adults exhibit, particularly when in pain or distress, is the chief characteristic of this wanting to "take from" that Woodworth has described.

Gregarious Instinct

Man, apparently, has certain instinctive responses to the presence and behavior of other men, in addition to fighting, sex, and parental responses. The following discussion presents certain wants that men have. Whether or not they are all native is another question.

Man Wants to be With Others.—When alone he is restless and uneasy. When in a crowd he is more or less satisfied. Ostracism is a real punishment. This instinct is one of the causes for people's leaving the farm and congregating in cities. (Rivers[2] believes there is also an opposite instinctive tendency to *seek solitude* under certain conditions, as was exhibited by many men during the War and as is shown by some when fishing, hunting, or in selecting particular jobs for their daily work.)

[1] R. S. Woodworth, *Psychology*, 1921, p. 150.

[2] W. H. R. Rivers, *Instinct and the Unconscious*, 1920, p. 150.

Man Wants to Watch Others.—Much of the fun at Coney Island consists of being in the crowd, of watching others, and of being noticed in turn.

Man Wants to be Noticed by Others.—In a large city we are "fed up" on this most of the time. But we often catch ourselves becoming annoyed because someone does not notice us. In rural communities everyone wants to be spoken to. Saluting in the army is a custom which has grown out of this want. Both private and general want to be noticed, and from my observation, they are equally incensed when they are ignored.

Man Apprehends in a Feeling Way Simple Emotions Expressed by Another.—The preceding three wants are possibly all phases of this tendency. We want to be with people, to watch them, and to be noticed in order that we may enjoy the emotions that are aroused by these contacts.

McDougall[1] writes that each instinct can be aroused by the expression of that instinct in another, and calls the process *sympathy*, or "sympathetic induction of emotion or feeling." So the expression of fear by A makes B fearful; expressions of love by A arouse B emotionally in the same way; etc. This seems to be true of some cases but not all. Throndike[2] points out that "the spectators of an infuriated man, or of two men raging at each other, are not thereby provoked to similar acts and feelings. They manifest rather 'curiosity-wonder,' forming a ring to stare, the world over." So also, "A's fleeing from B does not make B flee from A; nor A's shrinking from B make B shrink from A; nor A's self-abasement before B make B abase himself before A."

The view of the writer of this book is that although man does not always tend to act as another is instinctively acting, he does apprehend *in a feeling way* the emotion which another shows when that emotion is of a simple, instinctive sort. It is not contended that there is understanding in any intellectual sense, but merely an unanalyzable appreciation of the emotional state of the other person. Little children giggle sentimentally when the hero kisses the heroine at the "movie," although they understand very little of the situation and can express still less of it in words. A baby will alternate between shrieks bordering on terror and shouts of joy as the parent changes his expression from angry

[1] W. McDougall, *op. cit.*, p. 93ff.

[2] E. L. Thorndike, *op. cit.*, p. 117ff.

attack to laughter. My three children could not control themselves in this respect—any of them—until about five years of age.

The most striking examples of the ways in which we not only emotionally *feel* but in addition *behave* as other do are: "smiling when smiled at, laughing when others laugh, yelling when others yell, running with or after people who are running, running from the focus whence others scatter, jabbering when others jabber and becoming silent when they become silent, crouching when others crouch, chasing, attacking, and rending what others hunt, and seizing whatever object another seizes." These are "the chief, or even the only components of the *imitative tendency*," according to Thorndike, "which shows itself in large masses of men, and produces panics, and orgies, and frenzies of violence, and which only the rarest individuals can actively withstand."

The behavior of an individual instinctively aroused is always a prepotent stimulus interesting us. Whether we join with him or do something entirely different depends upon the sum total of all the stimuli affecting us at the moment and the wants that are controlling action.

It is along this line that explanation must be developed to account for the surprising quickness with which all, including small children, "size up" a stranger and show a like or dislike for him. Such reactions are, of course, often mistaken; but the point is that they are made, and at the time we are sure they are correct. The systems advertised so widely by which we may learn to size-up strangers in terms of physiognomy, shape of hands, phrenology, etc., are to be sure, all poppy-cock.[1] So far no one has studied the expression of the face and the general manner of a person when he enters a room, says "Good-morning" and shakes our hands, his reaction to the back-and-forth play of conversation, or our own emotional reactions to him, yet it is probably in terms of these expressive factors that we come to like or dislike the newcomer.

Man Uses His Vocal Organs to Affect the Behavior of Others.—A baby cries when hungry, uncomfortable or in pain. To these cries the parent responds instinctively. Children and even adults, when suddenly frightened, shriek with terror, and this cry is different from that which accompanies pain. Other human

[1] See H. L. Hollingworth, *Vocational Psychology*, for a general discusson of this subject.

beings instinctively notice these cries and respond in a great variety of ways, depending upon circumstances. Male animals make as frightening noises as possible when attacked or about to attack. In addition to these vocal activities which man has in common with many other animals, it is to be noted that man has a speech mechanism of which he very easily gains control. So much is native. The particular sounds he comes to make and their organization into language are acquired. Speech is evidently for the purpose of affecting others so as to gain what one wants, to obtain notice and secure approval. It is undoubtedly very important also in connection with thinking processes, but the relationship is a matter of controversy. Laughter, the enjoyment of the comical, etc., are other activities related to speech. But here again there is very great speculation and little or no agreement regarding the explanation of them.[1]

Man Wants to Show Approval and Disapproval.—When another exhibits any instinctive act of strength or daring, or rescues us or others from fear, or relieves us from hunger, or shows gorgeous display, we instinctively show approval by smiling, or staring in a respectful manner, or shouting encouragement.

On the other hand, evidences of physical weakness and meanness, emptyhandedness, deformity, and cowardice cause us to frown, hoot, and sneer.

One has only to attend a baseball game to see both of these instinctive responses shown repeatedly. Often we see a crowd reverse itself within a few minutes, first hooting and yelling at a player for muffing an easy catch, and then cheering just as vociferously over the successful handling of a difficult one.

Approval and disapproval are shown instinctively, it would seem, only toward actions of physical strength, daring, and the like, or their opposites. They are not shown natively toward manifestations of moral character or of good manners. Habits of approval and disapproval toward such behavior must be developed. And they are developed with surprising ease in many cases. The necessary condition for their development is the approval of the crowd or that of a recognized leader. So a boys' gang is good or bad depending upon the character of its leader. What we wear, think and do is largely controlled by what others about us wear, think, and do. Only the exceptional

[1] E. L. Thorndike, *op. cit.*, p. 157ff.

man deviates from the standards of the crowd, and then usually in a few respects only.

Man Wants to Receive Approval and Wants to Escape Disapproval.—When we receive approval we feel satisfied, and continue doing what we are doing. When disapproval is experienced we feel dissatisfied; we stop doing what we are doing, and tend to do something else. For example, a professional ball-player, after having muffed an easy fly, adjusted his hat three times, removed his glove and put it back on twice, spat on his glove four times, shifted his position several times, pulled up his trousers three times, and made many minor movements, in response to the hooting of the crowd, to which he pretended not to pay any attention. A few minutes later he caught left-handed a high fly, and on walking back to his station made none of these movements, but merely smiled, squatted down, and remained quiet as long as the crowd continued to show its approval.

Here we have the explanation of self-conscious and suggestible attitudes studied in Lesson 9. The individual is afraid of disapproval and is watching for signs of it instead of tending strictly to his work.

Because man receives approval and disapproval very largely on the basis of physical strength and daring rather than of more highly cultured performances, there is a steady tendency in society to run downhill in the latter respect. Keeping up culture standards requires work on the part of those who stand for the higher things of life. And physical leadership gives a great advantage to a man, regardless of his other attainments. President Wilson undoubtedly lost prestige when he declared us "too proud to fight." And much of his failure to influence society was due either to his indifference or to his inability to state his idealism in more primitive concepts which the mass of men would and could approve.

This want of man explains the surprising ease with which people change established personal habits—such as calling a quarter "two bits," or eating with the knife—in a short time simply in response to contempt from others whose good opinion is desired. Here is one of the teacher's strongest weapons in getting boys and girls to acquire all sorts of habits. And the more thoroughly the teacher is looked up to, the easier it is for that teacher to secure compliance with his request.

Although man wants approval, he does not want it from any one he considers below him, unless it is expressed in a humble manner. So a pat on the back would never be accepted from a bootblack, although it is enjoyed immensely when coming from one's "boss." An example of what is called lack of tact is showing approval of a superior without at the same time expressing submission to his leadership.

Man Wants to Assert Himself; to Compel Approval from Others; to Lead Others.—Three distinct phases of this want are discernible. There is, *first*, a defensive type of assertion; *second*, an aggressive type; and *third*, an outgrowth of the aggressive type which takes the form of leadership. The first is unquestionably native; the second probably so; while the third, to the extent that it is different from the second, is largely acquired.

1. Defensive Type of Self-assertion.—Woodworth[1] has called attention particularly to this type of self-assertion. He points out that resistance of any sort to action that has been initiated acts as a stimulus to the putting forth of additional energy into carrying out the action. For example, in running a lawn-mower a small amount of energy is used. But when a snag is encountered more energy is instantly released, and one shoves and shoves before stopping to extract the stick caught between the blades. One just naturally prefers to exert more and more energy and finally cut the stick in two than to inhibit all activity in this direction and eliminate the trouble by other means. This "release of energy and onward striving" is the basis of self-assertion of the defensive type. All this is very similar to the fighting instinct. The distinction between the two is clear if one watches the behavior of a small child who has been caught by an adult. First he attempts to pull away, struggling with all his strength; later he becomes enraged and starts crying. At first there is merely the self-assertive reaction, characterized by more or less emotional states of *strain* and *effort* or *determination*. If success is not attained then the emotional state changes into anger and fighting reactions appear. If success is obtained during the first stage the emotional state of effort changes into that of *elation*. This we see clearly when the child succeeds in breaking away—the set, grim defiance changes into happy excitement

[1] R. S. Woodworth, *Psychology*, 1921, p. 161ff.

over the victory. Opposition to resistance or interference is accordingly native.

2. Aggressive Type of Self-assertion.—In addition to mere resistance to interference there is the more active aspect of self assertion. Thorndike[1] describes this tendency as follows: "There is, I believe, an original tendency to respond to 'the presence of a human being who notices one, but without approving or submissive behavior' by holding the head up and a little forward, staring at him or not looking at him at all, or alternately staring and ignoring, doing whatever one is doing somewhat more rapidly and energetically and making displays of activity, and by satisfaction if the person looks on without interference or scorn. There is a further tendency to go up to such an unprotesting human being, increasing the erection and projection of the head, looking him in the eye, and perhaps nudging or shoving him. There is also an original tendency to feel satisfaction at the appearance and continuance of submissive behavior on the part of the human being one meets. These tendencies we may call the instinct of attempt at mastery.

"Such behavior is much commoner in the male than in the female. In her the forward thrust of the head, the approach, displays of strength, nudging and shoving are also commonly replaced by facial expressions and other less gross movements.

"If the human being who answers these tendencies assumes a submissive behavior, in essence a lowering of head and shoulders wavering glance, absence of all preparations for attack, general weakening of muscle tonus, and hesitancy in movement, the movements of attempt at mastery become modified into attempts at the more obvious swagger, strut and glare of triumph. The submissive attitude may also provoke the master to protect the submissive one. If the human being protests by thrusting his head up and out, glaring back, and not giving way to advance, the aggressor either becomes submissive or there is more or less of a conflict of looks, gestures, yells, or actual attacks, until, as was described under the fighting instinct, the submission of one or the exhaustion of both . . .

"The original behavior in mastery and submission, and in disapproving, being approved and being scorned, derided and neglected, becomes very much complicated by differences in the

[1] E. L. Thorndike, *op. cit.*, p. 92ff.

sex of the person who is the situation and in the sex and maturity of the person who is responding, by an increase in the number of persons who are the situation, and by the presence in the situation of elements provocative of curiosity, fear, anger, repugnance, the hunting instinct, kindliness, sex attraction and coy behavior. My account of attempt at mastery would be only partly true of any cases save those where the situation and the response were the behaviors of two males of about the same degree of physical maturity. Mastery and submission are fit illustrations of the universal fact that the many unit tendencies to respond to characteristic situations combine in elaborately complex totals. This fact makes the original social tendencies of man seem, at first sight like a helplessly unpredictable muddle of domineering, subservience, notice, disregard, sex pursuit, aversion, showing off, shyness, fear, confidence, cruelty and kindness. It also makes such unit-tendencies as I have described under approval, scorn, mastery and submission seem abstract and schematic, as indeed, they are . . . We may be confident, however, that did we know enough, we should find that whether a person will in a given case be shy, or indulge in display, or alternate between the two—whether he will domineer or plead in courtship—whether he will respond towards a given child by approval, domineering, bullying, protection, hunting, or fondling—could in every case be prophesied from knowledge of the situation and of him."

No statistical study has ever been made as to whether all individuals possess this instinct, and if so, whether to the same degree of strength. Yet we have all manner of social theories based on belief in the absolute equality of all men; or on belief that some are born to lead, the remainder to follow abjectly; or on all manner of intermediate positions.

3. Leadership is, I believe, based on both phases of self-assertion. But it is more than that. The play of children will illustrate the point. One child wants to build a fort with his blocks, another to play bear, and a third to play school. Each wants his own way and resists interference, but each also wants the others to play with him and to approve of his game and of him. Solutions to this are many and varied. One child may get his way (lead and the others, follow); or they may each go off and play alone (self-assertion satisfied but lack of gregariousness and approval); or they may all join another group (gregariousness

satisfied, coupled with submission not to each other but to someone else); etc. The most satisfying solution to each child is to play his own game and to lead the others in that game. But such domination can be, and is, obtained only through superior physical or mental ability, coupled up with genuine self-assertion. Leadership is accordingly based on native self-assertion and on mental and physical superiority over one's fellows, but the form it takes develops out of experience. If this is true, provision should be made in educational institutions for the development of leaders from among the superior individuals who show aggressive self-assertion.

Disobedience is in many cases nothing more nor less than self-assertion; in other cases it is due to ignorance. Obedience consists of habits which run counter to this instinct. They are built up in terms of the want to please a beloved one or of the want to escape punishment (fear). In the first case children are obedient in order to please, and so do not tend to be obedient when their friends are not present; in the second case they are much more likely to obey strangers. The best type of obedience has a mixture of both elements in it.

Display—Showing-off.—The instincts of self-assertion and responding to approval are modified in a great variety of ways. Habits which secure approval and permit of self-assertion are formed amazingly quickly, and are dropped just as quickly when they no longer bring the desired behavior from others. Many such habits can be designated as showing-off, or display. So children show off before visiting children or adults, continuing to do anything they have hit on that secures approval and changing to something else as soon as they are no longer noticed. Much social exchange between adults is for no other purpose than just this. The most extreme case that the writer has encountered is that of a young stenographer who fainted one day in her office. The doctor and nurse who took her home testified that she had fainted from sheer lack of food. But she had on at the time $150 worth of new clothing!

Williams[1] has called attention to three interesting phases of the matter of display among workmen. "Where a man can show by his house or by his flivver or by other of his possessions that he is 'getting on,' a very definite value is given to earning

[1] W. Williams, *What's on the Worker's Mind*, 1920, p. 124f., 273ff.

the wherewithal. But in a community where no house can be bought—because the town may not be there a few years later—and where the roads may be too bad for a flivver, then the other way of indicating the status of a self-respecting man who is 'as good as the next one' would seem to be by that of 'conspicuous leisure;'[1] which is obtained, not in the ordinary way of working, earning, and then buying, but by not working—by walking out of the mine at two o'clock while some other chap is so much a dub of a worker that, in order to make a living, he has to stay in till the day is ended at four."

Again he writes, "This revolting filth of speech is the most disappointing thing I have found in my travels. But I am still sure it is connected with long hours and with the difficulty a worker has in expressing in his work his individuality and in feeling himself progressing—that, together with the necessity of his showing himself as good as the next man in whatever lines of competition may be set up in this group . . . Apparently, the attractivenss of whiskey is that it offers one way of fulfilling the wishes of sobriety— a false fulfillment of those hopes which remain so difficult of fulfillment under actual conditions. In that case the man who drinks is at least continuing to dream of and hope for those fulfillments—and so to possess, still, something of a mainspring or motive for his upbuilding, provided its escapement can be better controlled and directed."

Snobbery, to which we are all addicted more or less, is another way of expressing display, of asserting superiority and calling for approval. Poor grammar, improper eating habits, lack of membership in a fraternal order, wearing clothes out of style, etc., *ad infinitum*, are the grounds on which we push our fellows down and thereby elevate ourselves. And because none of us likes to be disapproved of, we devote a great deal of attention to these "little" things and often worry more about them than about really important matters. Many a woman cannot forget her failure to leave the proper cards on some occasion, although she is quite oblivious to the fact that she has injured another's reputation by her gossip on the same occasion. Cheating at cards and non-payment of gambling debts are damned among men, although it may be considered only a joke to defraud a tradesman.

[1] See T. B. Veblen's very interesting discussion of this subject in his *Theory of the Leisure Class*, 1912.

Ambition.—"Hawkins[1] has defined ambition in much the way that most of us view it in connection with ourselves. He says: "We want to make names for ourselves, to earn plenty of money for our needs, and to have the gratification of consciousness that our life work is of real benefit to our fellowmen." Webster's Dictionary gives the definition of ambition much more as we see it exemplified in others—i. e., "an eager, and sometimes an inordinate, desire for preferment, honor, superiority, power, or the attainment of something." We would do those things which would make others look up to us with approval; we want to experience the enjoyment resulting from approval and submission.

"But life is very complex, and there are many ways by which we may obtain such gratification. The writer knew a man years ago who was perfectly willing to work at common labor, although he could do better work, and to allow his wife to run a boarding house to maintain the family. He had no ambition to earn more money or to keep his wife in comfort. His whole mastering instinct was concentrated on playing checkers, on winning in that game, on being looked up to as the best checker-player in town. And apparently he secured enough gratification from such success as to satisfy him, even though during most of the day he had to assume a submissive attitude toward others.

"No one, not even the President of the United States, can be a real leader in every respect. Consequently, we all very rapidly establish certain standards for judging our worth. We say to ourselves, 'I don't pretend to know anything about this thing or that. Let those who do get all that's coming to them. But I will succeed along this line. I'll make people recognize my worth here.' And so a hardware dealer may never have a thought of competing for distinction with his dentist or the minister or the circuit judge. But every act of his rival around the corner is watched with the greatest interest, with either secret gratification at his errors or great dissatisfaction and worry over his successes. This same hardware merchant may also be ambitious in Sunday-school work. There, again, every act of those he looks upon as rivals becomes of tremendous importance."[2]

Rivalry is a definite form of ambition in which one endeavors

[1] N. A. Hawkins, *The Selling Process*, 1918, p. 18.

[2] E. K. Strong, Jr., *Psychology of Selling Life Insurance*, 1922, p. 119ff.

to surpass another. It is essentially based on the fighting instinct, but modified by the self-assertive instinct. "It differs from the combative impulse in that it does not prompt to, and does not find satisfaction in, the destruction of the opponent. Rather, the continued existence of the rival, as such, but as a conquered rival, seems necessary for its full satisfaction; and a benevolent condescension towards the conquered rival is not incompatible with the activity of the impulse, as it is with that of the combative impulse."[1] Thus, in a game of chess one player will often insist that his opponent take back a move whereby the opponent's queen would be captured. Victory is not desired except when one has really won. The best form of rivalry is shown by many a scientist or engineer today who gives up his secrets as fast as he discovers them, desiring only a reputation for success. This desire to surpass others is used, of course, in countless ways in the schoolroom. It is fine for the child who can win even occasionally, but hard on the child who always loses.

Construction—Workmanship.—The desire to do constructive work is essentially a form of rivalry. Many writers contend that there are instinctive tendencies to construct things, or to work, and particularly to take pleasure in the products of one's work. But the point of view of the writer of this book is that there are no such original tendencies, but that these are various ways in which an individual strives to secure approval and to lead others. Small children show, if anything, a tendency to destroy, to tear apart—*not* to put together. They must be taught to do constructive things. And here they tend to construct only so far as to secure attention, and favorable attention at that. Paper dolls may be cut out in a most ragged way, but if the other girls do not do any better, and the mother beams with interest, the performance is allowed to pass. But if the standard of perfection is higher, then the work must be done better or there is no reward for it—reward being the favorable attention given it by others.

Good and Bad Types of Leadership.—Leadership in the past has been gained by self-assertion and fighting, by adventure and conquest. Competition between one company and another, one labor union and another, between capital and labor, and between one country and another, has been and still is to a

[1] W. McDougall, *op. cit.*, p. 116ff.

considerable extent carried on because of the sheer satisfaction of securing and maintaining domination of others. The scholar or scientist represents a different ideal in leadership. He does not aim to manipulate or dominate others but to advance the frontiers of knowledge and apply what is learned so as to benefit mankind. Much more of such achievement should be taught in school in order to inculcate such an attitude in the coming generations. In the words of Schwab, the new type of leader is "not the man who substitutes his own will and his own brains for the will and intelligence of the crowd, but the one who releases the energies within the crowd so that the will of the crowd can be expressed." Baker, commenting on this statement, writes, "His view corresponds closely with that of the foremost thinkers upon industrial reconstruction both here and in Europe; and that is, that these are vast undeveloped resources of knowledge, energy and creative genius in the human factor in industry; and that the next great step forward in civilization will consist in releasing this knowledge, energy, genius of the great masses of the worker."[1] Here is a challenge for the teacher and the psychologist!

Man Wants to be Submissive.—According to Thorndike[2] we make the abasive response when we meet a human being who is larger than ourselves or of angry and mastering aspect. "When weak from wounds, sickness and fatigue, the tendency is stronger. The man who is bigger, who can out-yell and out-stare us, who can hit us without our hitting him, and who can keep us from moving, does originally extort a crestfallen, abashed physique and mind." These stimuli are added to from experience so that in adult life we are very apt to show submission to superiority of any kind whether of physical size, of mental ability, of social standing, or of wealth and power. And we do this in response not only to real indications of these things but to anything that suggests them. So we submit to the loudly dressed man or the occupant of a large auto although the former may be a street-car motorman off duty and the latter may have squandered all his earnings for a ride.

The response to these stimuli seems to express itself in a slinking, crestfallen behavior, a general diminution of muscular tone,

[1] R. S. Baker, *The New Industrial Unrest*, 1920, p. 166f.

[2] E. L. Thorndike, *op. cit.*, p. 92ff.

slow, retarded movements, a hanging-down of the head, and sidelong glances.[1]

This instinct to be submissive to others is possibly the hardest of all to understand, just because none of us like to admit that we are submissive. But we are, and the most surprising part of it is that we obtain great satisfaction therefrom. Hero-worship is of this mode of behavior. That we enjoy. So do we enjoy following a real leader, such as Roosevelt.

The more thoroughly we approve of a leader, the more we will approve any action of that leader. This explains why we often have been very much annoyed afterwards when we came to realize that what we had approved was not in agreement with our customary standards. If the leader goes too far, we may not approve, but if we have been truly submissive to him, we may not show our disapproval, but keep quiet or walk away. Because of this many a dominating politician or labor-leader controls groups of men even at the polls, while they secretly damn him for his immoral or unfair conduct.

As one is always submissive to the group to which he belongs, he always enjoys praise from it. But he may become most resentful if the same praise comes from a group which he looks down upon.

Stage-fright is a striking example of submissiveness to the group. This appears in milder form, as nervousness, when one stands out from among the group in any way. Teachers are all familiar with the effect of number in the class upon the willingness and even ability of the students to stand up and recite. Nearly everyone can and will talk in a round-table seminar. But few will volunteer in a class of fifty and practically none will do so in a class of one hundred. The average individual so desires to do what the crowd does, and is so submissive to the group as a whole, that he is uncomfortable when he does otherwise, and in many cases is actually afraid to assert himself or to correct erroneous opinions against the crowd. Even the self-assertive man allows many things to go unchallenged rather than face the crowd, rationalizing his action on the ground that the point was irrelevant to the issue at hand.

This submissiveness of the individual to a group is one of the strongest factors underlying coöperation, causing unity of action

[1] W. McDougall, *op. cit.*, p. 64f.

of all in the group. Herein lies the tremendous strength of public opinion as it is variously presented through the press, the pulpit, the school and everyday contact with others. What others say and do quickly becomes law when we realize that many hold the same view. In this way the citizens of the United States became banded together after War was declared because everyone was doing the same thing. It is this same principle that explains the strength of superstition, social etiquette, customs, the moral law, and ideals held by the group. To stand out against them is to stand up against the group and usually to court disapproval. On the other hand, agreement gives us a sense of security and the sweet pleasure of being one with the group. Pillsbury has very aptly summarized all this when he writes, "Certain men, the leaders, can give a reason, if not the reason, for a particular belief; some contrary-minded individuals are spurred to skepticism by the prevalence of any doctrine; but the great majority accept their beliefs from the parson, from the latest book, or from a fashionable lecturer just as they take their hats from the best milliner. The attitude might be rationalized by saying, 'If all the best people accept it, it may be right; at least it saves thought, for, after all, nobody *knows*, and it is as well to be in good company.' "[1]

Shyness, Bashfulness, Self-consciousness.—"Shyness seems to consist chiefly in hesitancy and restraint of movement (most easily noticed in speech), lowering of eyes, and averted face." Thorndike suggests that "it may be submissive behavior minus the gross bodily cringing, and the inner acceptance of subserviency, and that it occurs as what is left of the response of submissive behavior when the condition of the person responding, or of the situation to which he responds, possesses elements which inhibit these. Thus when a powerful and hostile crowd would provoke submission *in toto*, a mere crowd or a fairly friendly crowd provokes shyness, and the speaker simply cannot look at them squarely or speak naturally."[2]

Bashfulness, or self-consciousness, is the resultant of a situation which simultaneously arouses both the self-assertive and

[1] W. B. Pillsbury, *The Psychology of Nationality and Internationalism*, 1919, p. 36.

[2] E. L. Thorndike, *op. cit.*, p. 94ff. See also, W. McDougall, *op. cit.*, p. 50ff.

submissive instincts. Thus in the case of Sam and Mabel (see Lesson 1), Sam was bashful because he wanted to show off and assert himself (sex instinct), but at the same time felt unaccustomed emotional disturbances within himself which upset him and made him very conscious of himself. Bashfulness is thus the unpleasant struggle within the individual tending to respond in these two opposing ways. Consequently the individual one moment may do nothing (both forces checking each other), the next moment retreat or hide, as the little child hides in his mother's dress, and the next moment show off.

Bashfulness, shyness, or stage-fright are overcome through becoming accustomed to the situations which cause them. They seem to be entirely overcome by many. Others never entirely conquer it. Such persons may suffer within, but they are able to control themselves so that no one suspects their emotional disturbance. The experiences of John Hay, one of our greatest Secretaries of State, are thus described: "Speech-making, even when he had his manuscript before him, was always an ordeal. In composing, he alternated between buoyancy and depression; first, the hot fit, when ideas flamed into his mind; then, the cold fit, when he read over what he had written and the words seemed gray and bleak and cold. He suffered by anticipation the misery of stage-fright. But once on the platform, although nervous to the end, he rarely failed to win the audience. This success came always as a surprise to him, and he used to chronicle it in his notes to his friends, not out of conceit, but as a bit of unexpected news which might surprise them too. 'Luckily,' he once said, 'the shakes go to my knees and not to my voice.'"[1]

PLAY

Play is not a single instinct. The term covers those activities of children and even adults which are carried on for their own sake and not deliberately for some future gain. Possibly the chief cause of play is the development of more energy than is needed with the attendant want to use it up. Sick children play little or not at all for this reason. The instictive side of play is then sheer activity plus responding to prepotent stimuli and in some cases "hunting" for such stimuli. The specific activities

[1] W. R. Thayer, *Life and Letters of John Hay*, Vol. I, p. 431f.

in play are mostly learned from one's fellows. Because it makes little difference to the average child what he does so long as he is active and securing approval, it behooves the educator to supply useful activities so as to crowd out useless and vicious ones. The Boy Scout movement is an excellent illustration of such substitution. Not only should education include such useful substitutions for child life but also it should prepare children to play in an enjoyable and useful manner when adults. One of the tragedies of adult life today is the inability of so many to play.

LESSON 35

FUNDAMENTAL WANTS (continued)

Get acquainted with one or more of the references given below, using the time usually devoted to a laboratory lesson. As you read what other writers have to say on the subject of man's instincts or native wants, fit the material into the contents of the lessons in this text as well as you can; and so work up your own list of man's native wants.

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LESSON 36

ACQUIRED WANTS

Dissatisfaction is, as we have seen, a primary cause for making new adjustments to our environment. For, when dissatisfied, man ceases doing what he is doing and does something else. And he continues making one response after another until exhausted or until satisfaction is obtained. A half-grown cat has about three wants: To eat, to use up excess energy and to sleep. These wants are satisfied one after the other, and that is all there is to life. If food is hard to find all the excess energy may be used up in hunting food, and the three wants are thus reduced to two: Finding and eating food, and sleeping. Man has many more wants than a half-grown cat. In fact, he has so many that it is well-nigh impossible to satisfy them all. Consequently, he is ever on the move, doing this and that, sometimes quite contented because his wants are pretty well satisfied, as just after a good meal; but more often rather discontented, because one or more wants are arousing dissatisfaction and restlessness.

What man does in life is dependent on the driving power of his wants, on his abilities and on the elements in his environment. For when he is restless from the lack of satisfaction of wants he moves about responding to one stimulus after another in his environment. If the appropriate stimulus, which will lead him to act in a satisfying way, is not present, then he will not satisfy his want. As Cattell once expressed it, "What man *can* be depends on his heredity (his wants and abilities); what he *may* be depends on his environment."

In attempting to escape from many dissatisfying conditions man comes to make the same responses again and again. So he goes to the spring or the faucet when thirsty, puts on gloves to keep his hands warm, wears a collar to secure approval, etc., etc. These responses are first made to escape from dissatisfaction. But after they have been repeated many times they are no longer

viewed as ways to escape from dissatisfaction but rather as adjustments that are necessary in themselves. Under such conditions one tends to forget all about the original want and the dissatisfaction of not satisfying it, to overlook the fact that the habit has been acquired, and to pay little or no attention to the response that is made, but instead to be very conscious of the object and to view it as the whole of the want. So a woman who has struggled with sewing by hand, and then has used a sewing-machine for years, feels hardly at all the original want which was eliminated by the machine, and thinks little about the new methods of sewing, but does view the machine as a necessity. Only when the machine gets out of order does she realize how indispensable it has become, and even then most of her attention is directed to repairing the machine. The machine itself, in other words, now stands in her mind very largely as a substitute for all that has led up to its discovery and use. So shoes are bought today with hardly a thought of the want to keep our feet warm, dry, and free from cuts. We merely reflect that the old pair is becoming worn out and we must have new ones. Moreover, the shoes are wanted so that we shall appear well before others. So we buy a new pair in order to satisfy the want for approval rather than to satisfy that original want which undoubtedly led to the invention of shoes. Most of us view a bathtub as a necessity. We would not rent a house that lacked one. We can hardly comprehend the original want which led Adam Thompson in 1842 to invent this convenience, nor can we readily understand why a certain city in 1845 made it unlawful to use one, except on medical advice!

This peculiarity of mental activity, which transfers attention from the original want to the object that has come to satisfy it, is responsible for many false explanations of conduct. Many assume that "gain of money" is the primary motive in life—that men work for money, and that money will buy anything. But as a matter of fact, money is desirable only because it stands as a symbol for the satisfaction of certain wants. Countless stories have been told of negroes who during the War accumulated a hundred dollars and then refused to work at any price until that money had been spent. All of us can illustrate this point from our own experience. But still the philosophy of the age is that money is supreme among all of man's motives. Another

motive often called primary is the "gain of utility." But the struggle here is not primarily to gain, but rather to eliminate some dissatisfaction; the "useful" object gained is useful only insofar as it aids in satisfying a want—it is never wanted just because it is a "utility" in the abstract. Few actually want an education until they have discovered in the struggle of life that without it they cannot satisfy their wants for prestige, power, influence, and leadership. Then they come to want this tool, this means of satisfying their inborn desires. By that time it is often too late, and then they struggle to give their children an education which the latter are sometimes reluctant to take, just because they do not yet feel any want for it.

Many acquired wants are accepted as we find them. So the child of today uses electric lights, phonographs, telephones, gas ranges, bicycles and automobiles. He cannot even conceive of a world without them. They are necessities which he uses in satisfying the same wants that his ancestors felt a thousand years ago but which were satisfied—if at all—by the use of other tools. But the child and the adult also acquire many new wants in their attempts to eliminate dissatisfaction. For example: The store bow and arrow of a neighbor are reproduced out of the best wood at hand; the school lesson is solved by mental manipulations or through the mother's help, depending upon circumstances; the circus is visited, and punishment for playing hookey is averted by means of a forged excuse; the desire to amuse a child leads to the making of a Kiddy-Kar; and the annoyances and loss of business because of traffic-jams are eliminated by condemning buildings and widening a street.

Acquired wants thus develop out of man's original wants and his environmental conditions. Because of his wants he looks for solutions. From among all the elements of his environment he selects that which is best fitted to satisfy his want. Thus if he wants to drive to a certain part of the city, his energies are directed toward selecting streets which have the best pavements and least traffic. But if he wants to rent a house he drives along other streets, going much more slowly and with his eyes set to see "For Rent" signs. The same is true in school. The child selects out of his geography lesson those elements which will best satisfy the wants he has in mind at the time. The best teacher is the one who arouses within the child those wants which

can be satisfied only by the essential and important elements of the lesson.

Motives

In Lesson 32 we attempted to answer the question, "Why do you attempt to solve this assignment?" And in doing so two kinds of answers were obtained. The first kind were *reasons* or explanations of why this was done rather than something else, statements of how the changes were to be accomplished. The second kind were *wants* or expressions of dissatisfactions that were to be changed into satisfactions.

A *motive* includes, then, both these elements. The cause of activity is a want, the cause of a particular activity is explained by reasons. In the absence of wants, man is inert, listless. With wants present he is alive, ready to act. His activity will depend largely upon his past experiences and his present environment. Because man is to so great an extent unconcerned with his wants, as such, and because he is so largely concerned in deciding between doing this and that in order to secure satisfaction, he very naturally explains his motives in terms of reasons. But as we have seen, such explanations are only partial answers; they do not go far enough.

Because man transfers his attention from the original want to the means of satisfying it, it is quite proper to speak of these means as acquired wants. For example, a young man wants to see his fianceé in a distant city. To do so he must work in order to get money to pay his expenses. Work and money are both means of satisfying the fundamental want: They are therefore wanted. But they are only secondary wants—acquired wants. And at the same time they are reasons. For, if the young man is asked "Why do you do this?" he replies, "I must work. I must earn money." They are explanations of why he does the particular job. Reasons express, then, what man has learned about his environment and himself that forces him to secure his wants in one way instead of another.

Some Examples of Redirection of Original Wants

The discussion so far has proceeded on the assumption that man's original wants remain unchanged throughout life. In one sense this is true. They remain operative until senility

approaches, and then some of them gradually weaken. But in another sense, it is not true. Man's wants are redirected in many ways. He learns, for example, to eat olives, oysters, and evil-smelling cheese which as a child he would not touch. He insists on niceties of etiquette, and feels keenly his failures to observe them—types of behavior which would have been incomprehensible to him as a child. In the struggle to adjust himself to his environment and obtain satisfaction, man's original wants are greatly modified. Let us consider certain of these changes.

Modification of Fighting Instinct.—We see this instinct operative in its simplest and least modified form in the behavior of the small boy. He loves to fight. A good share of his time is spent in bullying his sisters and girl friends, in wrestling and "play" fighting; and, when occasion arises, in the genuine article. Except when his behavior really interferes with the rights and happiness of others he should be allowed to develop as a little savage. For all men are likely to meet situations in life when they need to fight, and unless they have had experience they will be more or less helpless, or quite likely act the part of a coward.

The first step in modifying an instinct is to allow it to function (if that is socially possible). In this way the boy comes consciously to understand the instinct. Otherwise he can never be sure what he will do when it is aroused. All this means, in the case of the fighting instinct, that the boy should be allowed to know the sweet joy of "licking" another boy and—what is equally important—to experience defeat. Without all this a well rounded character can hardly emerge.

The next step is the elimination of many of the stimuli that cause fighting. Boys are taught not to fight girls, or smaller or weaker boys; also that fighting should be reserved for self-defence and in behalf of others who need protection. All this instruction he gets from his women-folks primarily, and from his men-folks in exceptional cases. The stories of great heroes and the examples of men and older boys are also factors in this instruction.

At the gang age[1] boys gradually come to fight for principles. For example, in early life boys play baseball 10% of the time and fight with fist (or mouth) 90%. As they grow older the fighting decreases and the playing increases.

[1] J. A. Puffer, *The Boy and His Gang*, 1912.

During this period each gang works out rules which govern the action of all. As the rules become more and more recognized as aids to playing, they are fought for more and more.

After the rules of baseball or any other game have been thus established as necessary means for maintaining continuous play, the desire for an umpire appears. When this stage has been reached, the boy is ready to be taught, and able to understand, the theory of government, which rests upon rules determined by the majority and enforced by officials appointed for the purpose. So boys can be led to appreciate and respect our courts, interstate commerce commissions, national treaties, and the idea of a league of nations. Thus the fighting instinct of the Anglo-Saxon, the great game-playing nations, is redirected on the fields of Eton and on every back-lot in America, away from continual resistance to interference, and toward defence of established rules. The Mexican boy, who gets no such training, does not later accept an election as does an Anglo-Saxon.

But the fighting instinct is modified not only with respect to the stimuli that arouse it, but also with respect to the responses that are made. The first substitution that takes place is to use the mouth instead of the fists. Then there come many other changes which only some men acquire. Debating is a modification of mouth-fighting. The profession of law is another such modification. And the employment of lawyers to fight for us is still another. The use of *Robert's Rules of Order* is a useful modification for organized groups. And so we might extend this discussion into the realms of politics, business, and all of life, and show that man has learned many, many ways of resisting interference and getting his way besides the instinctive method of using fists. These methods are of social value and should be encouraged and taught as part of our regular educational procedure and not left so entirely to the play life.

The true man of today is not looking for an opportunity to fight with his fists. His instinctive behavior has been changed too much for that. But he dearly loves to engage with others in a fight for some principle. Prohibition, vigilance work in advertising, pure-food movements, political campaigns, meeting the quota for one's city in a Liberty Loan—all these and many more appeal tremendously. Men love to overcome difficulties—the greater, the better. And when help is needed, if enthusiasm is

to be aroused, the *difficulties* should be played up, rather than the certainty of victory. Only victory won after a struggle is worth while and it brings a reward in man's instinctive life sufficient to compensate for the effort expended.

Modification of the Parental Instinct.—There are other modifications besides those pointed out in Lesson 34, but there is room here to mention only two. First, the parental instinct is the basis of altruistic behavior. All other instincts lead to action which benefits the individual himself, but in the case of the parental instinct the action is of more benefit to the child than to the parent. But it is also true that the parent cares for the child because he has to, because he obtains great satisfaction therefrom and simply cannot refrain from doing so. Woman, in particular, is truly uncomfortable at the sight or sound of suffering of all sorts, not only in children but also in adults and in animals. So it is in order to ease her own suffering, that she stops the small boy from holding the cat up by the tail. And out of this have grown our Societies for the Prevention of Cruelty to Animals, and to Children, and much of our legislation prohibiting child labor. Hospitals, reformatories, orphan and insane asylums, the Red Cross, and many reforms such as prohibition, pure food laws, and sanitation, are the outgrowth of this parental instinct. Christ in the Parable of the Good Samaritan showed that being a good neighbor or a good citizen consisted in being a father or mother to those in need. His teaching has helped through twenty centuries to redirect this instinct, so that sick adults as well as crying babies have been reacted to with tenderness and care. Possibly the loftiest expression of this directed instinct is to be found in St. Paul's famous chapter commencing "Though I speak with the tongues of men and of angels, and have not love, I am become as sounding brass or a tinkling cymbal."

The second modification is that appearing in *moral indignation*, which is a combination of the fighting and the parental instincts. For example, if A sees B injuring C, A reacts toward B in terms of anger and toward C in terms of tender emotion. Or A may react toward D in terms of both emotions if D has done wrong worthy of punishment. So of late society has been showing anger toward the criminal and has insisted on punishing him, but at the same time has experienced tender emotion toward him and has endeavored to reclaim him. "Paradoxical as it may

seem, beneficence and punishment alike have their firmest and most essential root in the parental instinct."[1] This combination largely accounts for our social order. For justice and law have gradually developed out of the inability of men to stand injustive any longer. In such cases today we often see men and women playing slightly different rôles. Usually it is the woman who stirs up people and inaugurates the crusade. Then when a "good fight" has been started man becomes interested and carries it on far beyond the point to which the woman's concern brought her instinctively.

Development of a Sentiment

On passing a pretty baby one smiles and feels good. In a few moments the tender emotion that was aroused has faded out. A sudden fright is similarly dismissed. So it is with the emotions aroused in a purely instinctive way. But man possesses certain emotional dispositions that continue. Love and hate are good examples; one loves or hates another over long periods of time. Whenever the individual is met or thought of this emotional disposition is immediately aroused. This is what Shand means when he says, "A *sentiment* is an organized system of emotional tendencies centred about some object."[2] Hart has given us another definition: "a system of emotionally toned ideas."[3] The two definitions refer to the same thing, but the first one emphasizes the emotional aspect whereas the second emphasizes the ideational aspect. Let us note how a sentiment may arise.

A stranger was entertained by a friend at his club for lunch. While eating he asked, "Why did a city develop here at Pittsburgh?" Several explained it by the amount of coal found in these parts, and by the transportation facilities afforded by the confluence of the Allegheny and the Monongahela Rivers forming the Ohio. At this point the stranger awkwardly spilt the soup into his lap, and was immediately filled with chagrin and the emotion accompanying the submissive instinct. On his return home, and on being asked what he thought of Pittsburgh, he replied with derogatory remarks, complaining of the water, the police system, the hotels, etc.

[1] W. McDougall, *Social Psychology*, 1918, p. 75; see also Chapter X.

[2] Quoted in W. McDougall, *op. cit.*, p. 126.

[3] B. Hart, *Psychology of Insanity*, 1912, p. 61.

Interpreting this psychologically we may say that at the moment that he spilt the soup he was gathering ideas about Pittsburgh. The soup-spilling accident occasioned an unpleasant emotion which in this case became firmly associated with the idea of Pittsburgh. The combination resulted in a *sentiment.* Later when Pittsburgh was recollected the incident with its unpleasant emotion also came to mind. Consequently the clumsy visitor disliked Pittsburgh. He could not say to his friends: "I dislike Pittsburgh because I made a fool of myself and spilt soup in my lap at a club luncheon." He had to give explanations that would sound reasonable and would not injure himself, but he had to express the unpleasant sentiment within him. Most of the derogatory, "catty" remarks we make are expressions of dislike of somebody who has injured our pride in some way.

McDougall explains love and hate as follows: When a man loves or hates another, "he is liable to experience any one of a number of emotions and feelings on contemplating that other, the nature of the emotion depending upon the situation of the other." So, "when a man has acquired the sentiment of love for a person or other object, he is apt to experience tender emotion in its presence, fear or anxiety when it is in danger, anger when it is threatened, sorrow when it is lost, joy when the object prospers or is restored to him, gratitude towards him who does good to it, and so on; and, when he hates a person, he experiences fear or anger or both on his approach, joy when that other is injured, anger when he receives favors."

McDougall adds: "It is, I think, helpful, at least to those who make use of visual imagery, to attempt to picture a sentiment as a nervous disposition and to schematise it crudely by the aid of a diagram. Let us draw a number of circles lying in a row, and let each circle stand for one of the primary emotional dispositions (Plate XXXVII). We are to suppose that the excitement of each one of these is accompanied by the corresponding emotion with its specific impulse. These dispositions must be regarded as natively independent of one another, or unconnected. Let A be the object of a sentiment of hate and B be the object of a sentiment of love; and let α in our diagram stand for the complex neural disposition whose excitement underlies the idea or presentation of A, and let β be the corresponding disposition concerned

in the presentation of B. Then we must suppose that α becomes intimately connected with R, F, and P, the central nuclei of the instincts of repulsion, fear, and pugnacity, and less intimately with C and S, those of curiosity and of submission, but not at all with T, the central nucleus of the tender or parental instinct. Whenever, then, α comes into play (i. e., whenever the idea of A rises to consciousness) its excitement tends to spread at once to all these dispositions; and we must suppose that they are thrown into a condition of subexcitement which very easily rises to dis-

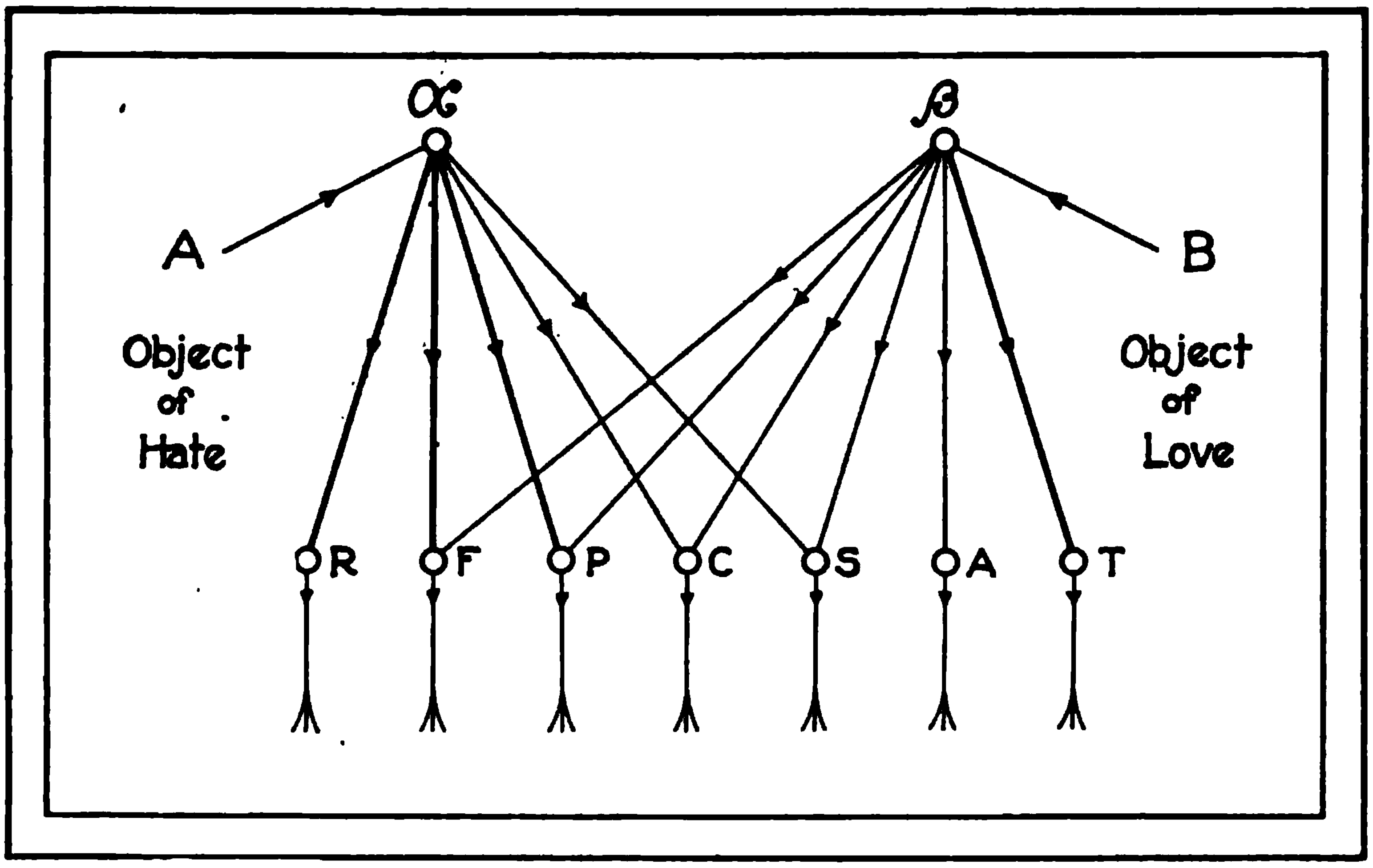


Plate XXXVII.—Diagram to illustrate the neural bases of the sentiments of hate and love. A is the object of the sentiment of hate, B that of the sentiment of love; α and β are the neural dispositions whose excitement accompanies presentations or ideas of A and B respectively; α is connected with the affective-conative dispositions R, F, P, C, S, and β with T, A, S, C, P, F, with degrees of intimacy indicated by the thicknesses of the connecting lines. The letters of the lower row stand for the names of the instincts, as follows:—R = Repulsion, F = Fear, P = Pugnacity, C = Curiosity, S = Subjection, A = Self-assertion, T = Parental instinct. (McDougall's diagram slightly modified here.)

charging point in any one of them, or in several of them together —e. g., in P and R, when the emotional state of the subject becomes one of mingled anger and disgust, and the impulses of these two emotions determine his actions, attitudes, and expressions. Similarly β must be supposed to be connected most intimately with T, the disposition of the tender emotion, and less intimately with A, S, C, P, and F and not at all with R. If this diagram represents the facts however crudely and inadequately, we may say that the structural basis of the sentiment is a system

of nerve-paths by means of which the disposition of the idea of the object of the sentiment is functionally connected with several emotional dispositions. The idea, taken in the usual sense of the word as something that is stored in the mind, may therefore be said to be the essential nucleus of the sentiment, without which it cannot exist, and through the medium of which several emotional dispositions are connected together to form a functional system. The emotional dispositions comprised within the system of any sentiment are, then, not directly connected together; and, in accordance with the law of forward conduction, the excitement of any one of them will not spread backwards to the cognitive dispositions, but only in the efferent direction, as indicated by the arrows in the diagram. Hence any one such disposition may become an organic constitutent of an indefinitely large number of sentiments."[1]

The Self-regarding Sentiment

The question can now be raised: How does man come to act in terms of an ideal of conduct and not in terms (1) of mere pain and pleasure, or (2) of the influence of rewards and punishments, or (3) of the anticipation of social praise and blame?

In this introductory course only certain aspects of the subject may be pointed out in attempting an answer to the question. The student who is interested should read, e. g., McDougall's *Social Psychology*.

McDougall holds that ideal conduct arises from the *self-regarding sentiment*, which has two varieties—*pride* and *self-respect*.

Pride.—The development of this sentiment can be exemplified as follows: "Imagine the son of a powerful and foolish prince to be endowed with great capacities and to have in great strength the instinct of self-display with its emotion of positive self-feeling. Suppose that he is never checked or corrected, or criticised, but is allowed to lord it over all his fellow-creatures without restraint. The self-regarding sentiment of such a child would almost necessarily take the form of an unshakable pride, a pride constantly gratified by the attitudes of deference, gratitude, and admiration, of his social environment; the only dispositions that would become organized in this sentiment of pride would be those of positive self-feeling or elation and of anger (for his anger would

[1] W. McDougall, *op. cit.*, p. 127ff.

be invariably excited when any one failed to assume towards him the attitude of subjection or deference). His self-consciousness might be intense and very prominent, but it would remain poor in content; for he could make little progress in self-knowledge; he would have little occasion to hear, or to be interested in, the judgments of others upon himself; and he would seldom be led to reflect upon his own character and conduct. The only influences that could moralise a man so endowed and so brought up would be either religious teaching, which might give him the sense of a power greater than himself to whom he was accountable, or a very strong natural endowment of the tender emotion and its altruistic impulse, or a conjunction of these two influences.

"A man in whom the self-regarding sentiment had assumed this form would be incapable of being humbled—his pride could only be mortified; that is to say, any display of his own short comings or any demonstration of the superiority of another to himself could cause a painful check to his positive self-feeling and a consequent anger, but could give rise neither to shame nor to humiliation, nor to any affective state, such as admiration, gratitude, or reverence, in which negative self-feeling plays a part. And he would be indifferent to moral praise or blame; for the disposition of negative self-feeling would have no place in his self-regarding sentiment; and negative self-feeling, which renders us observant of the attitudes of others towards ourselves and receptive towards their opinions, is one of the essential conditions of the influence of praise and blame upon us.

"In many men whose moral training has been grossly defective, the self-regarding sentiment approximates to this type of pure pride; such men may revel in the admiration, flattery, and gratitude of others, but they remain indifferent to moral approval; they may be painfully affected by scorn or ridicule, and but little by moral censure. And for most of us the admiration and the scorn or ridicule of others remain stronger spurs to our self-feeling than praise or blame, and still more so than mere approval and disapproval."[1]

Self-respect.—"The self-regarding sentiment of the man of normally developed moral nature differs from pride in that it comprises the disposition of negative self-feeling (emotion accompanying submissive instinct) as well as that of positive

[1] W. McDougall, *op. cit.*, p. 197f.

self-feeling (emotion accompanying self-assertive instinct); it is the presence of this disposition within the sentiment that distinguishes self-respect from pride. We have seen that negative self-feeling is normally evoked by the presence of any person who makes upon us an impression of power greater than our own, and that its impulse is to assume an attitude of submission towards that person, an attitude which becomes in the child, as his intellectual powers develop, an attitude of receptivity, of imitativeness and suggestibility. The main condition of the incorporation of this disposition in the self-regarding sentiment is the exercise of authority over the child by his elders. At first this authority necessarily demonstrates its superior power by means of physical force, later by means of rewards and punishments. On each occasion that the exercise of personal authority over the child makes him aware of a superior and inflexible power to which he must submit, his negative self-feeling is evoked; then his idea of self in relation to that person becomes habitually accompanied and suffused by this emotion in however slight a degree, and he habitually assumes towards that person the attitude of submission. Thus the disposition of this emotion becomes incorporated in the self-regarding sentiment. Thereafter all persons fall, for the child, into one or other of two classes: in the one class are those who impress him as beings of superior power, who evoke his negative self-feeling, and towards whom he is submissive and receptive; in the other class are those whose presence evokes his positive self-feeling and towards whom he is self-assertive and masterful, just because they fail to impress him as beings superior to himself. As his powers develop and his knowledge increases, persons who at first belonged to the former class are transferred to the latter; he learns, or thinks he learns, the limits of their powers; he no longer shrinks from a contest with them, and, every time he gains the advantage in any such contest, their power of evoking his negative self-feeling diminishes, until it fails completely. When that stage is reached his attitude towards them is reversed, it becomes self-assertive; for their presence evokes his positive self-feeling. In this way a child of good capacities, in whom the instinct of self-assertion is strong, works his way up the social ladder. Each of the wider social circles that he successively enters—the circle of his playmates, of his school-fellows, of his college, of his profession—impresses him at first with a sense of

a superior power, not only because each circle comprises individuals older than himself and of greater reputation, but also because each is in some degree an organized whole that disposes of a collective power whose nature and limits are at first unknown to the newly-admitted member. But within each such circle he rapidly finds his level, finds out those to whom he must submit and those toward whom he may be self-assertive. Thus, when he enters a great school, the sixth-form boys may seem to him god-like beings whose lightest word is law; and even the boys who have been but a little while in the school will at first impress him and evoke his negative self-feeling by reason of their familiarity with many things strange to him and in virtue of their assured share in the collective power of the whole society. But, when he himself has reached the sixth form, or perhaps is captain of the school, how completely reversed is this attitude of submissive receptivity! When he enters college, the process begins again; the fourth-year men, with their caps and their colors and academic distinctions, are now his gods, and even the dons may dominate his imagination. But at the end of his fourth year, after a successful career in the schools and the playing fields, how changed again is his attitude towards his college society! The dons he regards with kindly tolerance, the freshmen with hardly disguised disdain; and very few remain capable of evoking his negative self-feeling—perhaps a 'blue,' or a 'rugger-international,' or a don of world-wide reputation; for the rest—he has comprehended them, grasped their limits, labelled them, and dismissed them to the class that ministers to his positive self-feeling. And so he goes out into the great world to repeat the process and to carry it as far as his capacities enable him to do.

"But if once authority, wielding punishment and reward, has awakened negative self-feeling and caused its incorporation in the self-regarding sentiment, that emotion may be readily evoked; and there is always one power that looms up vaguely and largely behind all individuals—the power of society as a whole—which, by reason of its indefinable vastness, is better suited than all others to evoke this emotion and this attitude. The child comes gradually to understand his position as a member of society indefinitely larger and more powerful than any circle of his acquaintances, a society which with a collective voice and irresistible power distributes rewards and punishments, praise and blame,

and formulates its approval and disapproval in universally accepted maxims. This collective voice appeals to the self-regarding sentiment, humbles or elates us, calls out our shame or self-satisfaction, with even greater effect than the personal authorities of early childhood, and gradually supplants them more and more. And, when any individual passes upon us a well-founded judgment of moral approval or disapproval, he wields this power; and, though he may be personally our inferior, his expressions may influence us profoundly, because we realize that his moral judgment voices the collective judgment of all-powerful society.

"The exercise of inflexible authority over the child prevents, then, his self-regarding sentiment taking the form of pride in the strict sense, pride that acknowledges no superior, that knows no shame, and is indifferent to moral approval and disapproval; it gives the sentiment the form of a self-respect that is capable of humility, of the receptive imitative attitude of negative self-feeling; and, by so doing, it renders the developing individual capable of profiting by example and precept, by advice and exhortation, by moral approval and disapproval."[1]

[1] W. McDougall, *op. cit.*, p. 199ff.

LESSON 37

MAN'S WANTS (continued)

Again employ the time usually devoted to the preparation of a laboratory lesson to the reading of assignments given in Lesson 35.

Consider the last ten full-page advertisements in the current number of *The Saturday Evening Post.* Write down the acquired wants that are to be satisfied by the commodities advertised for sale; and then, second, what the primary wants are that cause the acquired wants to be wants. (In this connection, recognize the fact that twenty-five years ago buggies were bought by many people. The automobile has now taken their place. The original wants of man have not changed during this quarter-century, but his acquired wants have.)

LESSON 38

HOW DIFFICULTIES ARE SOLVED

We have seen how man learns to do any performance better and better and we have just seen what are the performances he naturally wants to do. But how does man hit upon the right response to a new situation to which he has no instinctive or habit-formed response? How does he come to turn to the right (or left) at a fork in the road? How does he solve an original in geometry? How does he decide a business difficulty?

The mirror-drawing constituted a difficulty-situation. It was mastered by trial and error. Are all difficulties so mastered? What does one do when he thinks, or reasons out the solution to a difficulty or a problem? Is the process trial and error also, or is it something quite different?

The term thinking, or reasoning, is usually reserved for mental processes showing a degree of originality, as contrasted with the rehearsal of a previously learned reaction. A new situation, which cannot be dealt with in a purely habitual way, offers the occasion for thinking, though it is not a guarantee that thinking will occur.

The laboratory hour will be spent in solving a simple puzzle. The object this time is not so much to solve the puzzle as to discover whether any mental process which we call reasoning is involved in solving it. Some persons will solve it without discovering a great deal about the general principles governing the solving process. Others who solve it but once or twice may learn a great deal about the matter. The difference between what different persons learn will depend upon how they analyze what they do. Consequently, try to solve the puzzle, but try far harder to discover what you do in solving it. Careful notes are necessary.

Problem.—How is a difficulty solved?

Apparatus.—A watch with a second hand.

Draw on a sheet of paper two parallel lines seven inches long and one inch apart. Then draw lines every inch connecting the two long lines together, thus producing a row of seven squares, one inch on a side.

Obtain 2 sets of 6 small objects, such as 6 pennies, 6 dimes, 6 buttons, 6 paper clips, etc. (Only 3 of each will be used at first.)

Procedure. *Part* 1.—Place, say, a penny on each of the three left-hand squares and a dime on each of the three right-hand squares. The middle square of the seven is now unoccupied.

The problem is now to so move the coins, one at a time as to bring all the dimes to where the pennies are now, and all the pennies to where the dimes are. The coins can be moved forward one place at a time, or they may be jumped over another coin. They may not be moved backward.

Solve this puzzle ten times. Keep an exact record of the time required to solve it each time. Also make as complete a record as possible of what you did while solving it each time. That is, *after each trial, write out as careful a description of your method of solving the puzzle as you can, the ideas that came into your mind, the movements you made, your feelings, etc.* (If any trial consumes considerable time, it is well to take out time for recording your introspections, as otherwise they may be forgotten.)

Part 2.—If you have time repeat the puzzle ten times, using a diagram of 13 squares instead of 7 squares, and using 6 men on a side instead of three.

Results.—Plot your data in the form of curves. On the base line (horizontal line) indicate the successive trials and on the vertical line the time required to solve the puzzle.

Record as accurately as you can just how you went to work to solve the puzzle, what you did, etc.

Questions.—(1) What would you say are the processes involved in solving a difficulty?

2. Did your procedure differ from that in the mirror-drawing experiment?

3. Did you do any reasoning?

4. How does reasoning differ from recall? Explain.

Application.

LESSON 39

HOW DIFFICULTIES ARE SOLVED—REASONING

If the average man were asked the definition of a difficulty, he would reply by saying that it is something hard to do or understand. And the implication would be that a difficulty is a sort of problem given by someone to someone else to be solved. This view is held because everyone remembers the thousands of difficulties concocted by teachers for him to worry over. And in addition he remembers the many duties assigned him by his parents which had to be done. And then there have been all sorts of objects and individuals who have interfered with what he wanted to do.

But just as we have seen that wants are not basically objects but internal dissatisfactions or lacks of satisfaction, so difficulties are not problems, nor duties, nor interfering objects, as such, but *situations* in which a want cannot be satisfied. If I do not want to go fishing there is no difficulty about getting bait; if I do want to go, that difficulty must be solved. If a boy does not expect to go to school after his sixteenth birthday, there are few real difficulties for him in school during his last few weeks. But problems ignored by him are real ones to the ambitious youth on his way to college. The same college student who turns in poorly prepared themes may write excellent editorials for the college paper. In the first case no real wants were involved; in the second case, genuine wants called for satisfaction only to be obtained through earnest effort. Bok tells us in his interesting autobiography how he refused to do his writing lessons because he did not want to write like the specimens in the copy-book. And even two good lickings made no impression on him. A difficulty always includes, then, an unsatisfied want as a very important element. But the difficulty includes, on the other hand, an environment in which the want cannot, for the moment at least, be satisfied. And to this external combination of objects and persons a reaction must be made either by responding to the complex stimulus and not satisfying the want, or by getting away

from the stimulus and finding another to which a response may be made that will more fully satisfy the want.

Most wants are solved immediately by reacting instinctively or in terms of acquired habits. Thus a cat on meeting a dog is instantly possessed of the want to escape and runs up a tree; or if cornered, it fights. Both these reactions are native solutions to the difficulty. So the baby cries when hungry. Later the child asks for food (an acquired habit developed out of crying). The fact of the matter is that most difficulties are so solved, either by responding to the whole difficulty or by responding to one or more of its parts (Law of Partial Identity). So in the problem, "James *has* six marbles *and* William *has* four. What is the difference in the number that they have?" the average child responds to "*has*" and "*and*," and adds six and four, instead of reacting to the whole problem, i. e., to its entire meaning. Most solutions depend, then, upon the existence of instinctive or habit-formed responses to the difficulty-situation. But human beings encounter situations to which they have no response and yet have to make one. In such cases a degree of originality, as contrasted with the rehearsal of a previously learned reaction, is demanded. Before attempting to answer the question, "How are solutions hit upon?" let us note certain other implications in, "Why are solutions attempted?"

First, it is clear from what has gone before that solutions are attempted to difficulties because in no other way can certain wants be satisfied.

Second, the emphasis in solving a difficulty is upon satisfying a want, not upon getting the right solution. A child, just promoted a whole grade, was given problems like these to solve—multiply 23 × 17. Due to habit he placed one under the other and drew a line. Then knowing nothing of multiplication beyond 9 × 9 and knowing that he was not expected to add or subtract, he proceeded to get an answer. This he did by multiplying seven and three, and one and two, and writing down 21 and 2 getting the answer 221. With this he was perfectly satisfied. Really, why shouldn't he be? But when the teacher disapproved of the answer he was confronted with a new want. He must now not only get an answer to each such problem, but also get one that would bring approval. This he utterly failed to do until an observant parent discovered his random efforts.

There are, then, two distinct problems as to how difficulties are solved. There is first, how are they solved naturally in everyday life? and second, how should they be solved so as to obtain correct solutions? The latter problem is too complicated to be attempted in an introductory course. But this general hint can be given. The more wants that are satisfied by a solution the more likely it is that the solution is the correct one. But a true solution will not be obtained by an individual who does not possess the mental habits that must be combined in some manner to bring about the solution. In the illustration above, the addition of the second want (teacher's approval) made it impossible for the boy to accept his original answers. But since he lacked the mental habits of multiplying he could not solve the multiplication problems by himself. (An exceedingly brilliant child might do so, working up to the proper method through the use of already established habits.)

Education helps one to obtain true solutions to life's problems through developing many acquired wants which must be taken into account when a difficulty is encountered and it supplies many facts and principles which can be manipulated in the efforts to solve the difficulty. But probably it does not improve at all the sheer mental functioning involved in solving difficulties, for such abilities are apparently inborn.

How Difficulties are Solved

The solving of a difficulty is essentially an effort to escape from a dissatisfying state and to reach a satisfying one. Five stages may be distinguished: (1) Dissatisfaction, (2) Finding solutions, (3) Testing the solutions, (4) Satisfaction, and (5) Accepting the solution. *For convenience in discussing the whole subject,* each of these stages may be subdivided into three levels.[1] (See Plate XXXVIII.) The first level represents the type of solving difficulties which we find primarily in animals, but also in man. The

[1] The "levels" are the degrees of conscious analysis in the problem solving process. On the first level there is a minimum of consciousness as to what is the difficulty; on the second level there is only a general notion of what the difficulty is, whereas on the third level the difficulty is finally isolated and comprehended so that it can be stated in words, and moreover there is a maximum of understanding of the steps employed in solving the problem.

The "stages" are the five steps which constitute the difficulty-solving process.

1st Level......	(*a*) Vague restlessness	(*a*) Looking for appropriate stimulus	(*a*) Response	(*a*) Satisfaction or dissatisfaction	(*a*) Continuing or discontinuing
2nd Level....	(*b*) Consciousness that something is wrong	(*b*) "Hunch" as to general solution	(*b*) Trying out 1. by manipulation 2. by mentally trying this and that	(*b*) Satisfaction or dissatisfaction	(*b*) Continuing or discontinuing in terms of entire setting
3rd Level......	(*c*) Consciousness of actual difficulty	(*c*) 1. Analysis of difficulty 2. Problem stated 3. Assumptions raised	(*c*) Mental rehearsal	(*c*) Satisfaction or dissatisfaction	(*c*) Continuing or discontinuing in terms of entire setting including rational proof

PLATE XXXVIII.—Showing Five Stages and Three Levels in Solving Difficulties.

third level represents the type found only in man, and then only under certain circumstances. The second level is intermediate. It is upon this level that man solves most of his difficulties. Whether animals behave in this way is a question not yet settled.

The Three Levels on Which Difficulties are Solved

On the First Level.—Man is first of all possessed by a vague restlessness. He does not know what is wrong, but he feels, rather than knows, that something is wrong. The restlessness causes him to move about, without really knowing why. In doing so he comes into contact with a variety of stimuli. To these he reacts. Some bring satisfaction, others dissatisfaction. Those that bring satisfaction he accepts as solutions to his difficulty, although they may not be true solutions at all. Consider an example. Johnnie comes home from school more hungry than usual because of having had less lunch than usual. In this case we postulate that the hunger is not sufficient to be consciously realized and that usually he does not get a lunch at this time of day. He is restless and does not settle down to play as usual. Soon he stumbles on an apple and asks for it. If the mother refuses, he wanders about. Then he thinks of candy and asks for a nickel. If refused again, he may try a drink of water. Later he may ask "How long is it till supper?" or request a slice of bread-and-butter. In this case the restlessness gradually becomes consciously identified with desire for food. Boys and girls in the early adolescent period show this restlessness when the sex instinct awakens. Often they do not come to realize what is the cause for some time. Home-sickness is, to some extent certainly, a restless dissatisfaction due to the absence of many familiar associations that made the individual feel at ease through satisfying the desire to be with people, to receive approval, and the like.

On this first level the four stages of finding a solution, trying it out, satisfaction and acceptance, are pretty much all one stage of responding to stimuli that are encountered and continuing to respond to them if they bring satisfaction and ceasing to respond to them if they bring dissatisfaction.

On the Second Level.—The individual is conscious that *something is wrong*. As he continues to pay attention to the dissatisfying state he develops a "hunch" as to what is wrong and a

"hunch" as to how to solve it. This he proceeds to test, either by actually trying it out or by thinking it out. If the solution brings satisfaction it is accepted; if dissatisfaction, he tries again. The longer his struggles continue before he finds a satisfying condition, the more likely it is that the difficulty will become clearly analyzed and the solving carried out in terms of the third level. But this change from second to third level does not necessarily take place. For example, most students are satisfied with any method in mathematics that gives the right answer. Freshmen in college seem to be peculiarly unable to determine just what is wrong with their methods in mathematics. A serious attempt to have each student in mechanical drawing report why he made each mistake has resulted in almost complete failure. Many an executive gets a "hunch" that something is wrong. His staff is called upon for solutions. As these are turned in the executive usually accepts or rejects them in terms of whether they satisfy or dissatisfy him, not upon whether they are logically correct.

On the second level there is a certain amount of localization of the difficulty and a trying-out of solutions that come to mind. Here again the satisfaction that results determines very largely what solution is accepted.

It should be noted that satisfaction in such cases results from three factors. The solution itself brings satisfaction; the whole setting which includes the solution brings satisfaction; and finally satisfaction comes because of escape from the strain of waiting for a solution. A little girl, for example, wants her warm wraps in order to go out and slide down hill. The coat is being mended and the mother brings out an old one, which is eagerly put on. She is satisfied. A few moments later she comes back crying and says, "They will laugh at me with this old coat on." The old coat satisfies the desire for warmth, but not the desire for approval from her playfellows. After waiting a long time for the new coat to be mended, the desire to escape waiting, plus the desire to slide down hill, may lead to acceptance of the old coat as a solution. It is not a perfect solution, but by accepting it, an escape is made from the steadily mounting dissatisfaction due to waiting.

Acceptance or rejection of a solution on the second level is based, then, much more on satisfaction or dissatisfaction in

terms of the entire setting of the difficulty, than in terms of the mere response.

On the third level, the individual is very much more conscious of what the difficulty consists of, and of the methods employed in solving it. The stages represent more or less clearly defined steps, and in the most advanced examples, the individual knows just what he is doing at any moment, and why, and just what remains to be done.

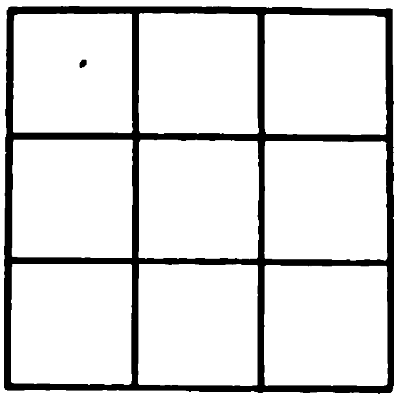
The Five Stages in Solving Difficulties

1. Dissatisfaction.—In everyday life one starts with vague restlessness that may gradually develop into the consciousness that something is wrong, if no satisfying solution is stumbled on; and this in turn may develop into the consciousness of an actual difficulty if again no solution has been hit upon. In the highly artificial life of the schoolroom the pupil has definite problems presented to him. But these are not real problems to him unless they are difficulties which affect his wants in some way. Only when they enter into his life does he make genuine struggles to solve them. Most thinking in the schoolroom is perfunctory and compares unfavorably with that going on in play.

2. Finding a Solution.—On the third level, where the highest type of thinking and reasoning takes place, three fairly distinct processes of finding a solution may be distinguished, namely, (*a*) analyzing the difficulty into its parts, (*b*) stating the problem in clean-cut language, and (*c*) raising one or more assumptions, or hypotheses, as to how it may be solved. These three processes do not take place in one, two, three order, but rather occur in random order, back and forth, each advance in any one of the three helping to advance the other two. In other words, each further analysis of the difficulty helps to formulate still more clearly just what the problem is, and both of these help to raise other assumptions or to strengthen or weaken assumptions already considered. Each new assumption may present a new point of view, necessitating further analysis of the original difficulty. All this is very well illustrated by candidates for a degree, who have to write theses. They flounder around trying this and that, changing the general problem from time to time. When they reach the point where they can formulate their problem in definite language they are about one-third through their thesis

work, for they have analyzed the problem quite thoroughly and have equally clear ideas as to how to go to work to solve it (have assumptions to test out).

Take as an illustration this puzzle: "Here are 9 squares. Put a figure (no two alike) in each square so as to make a total of 15 by adding them up and down, crosswise and diagonally."



While studying the figure and problem, suppose this assumption flashed into mind: "Maybe there are only a very few combinations of these figures adding up to fifteen; if I had them all before me, it might help to solve the puzzle." The combinations are then worked out. Here they are:

Combinations involving 1........	1–5–9	1–6–8		
Combinations involving 2........	2–4–9	2–5–8	2–6–7	
Combinations involving 3........	3–3–9	3–4–8	3–5–7	
Combinations involving 4........	4–2–9	4–3–8	4–5–6	
Combinations involving 5........	5–1–9	5–2–8	5–3–7	5–4–6
Combinations involving 6........	6–1–8	6–2–7	6–4–5	
Combinations involving 7........	7–2–6	7–3–5		
Combinations involving 8........	8–1–6	8–2–5	8–3–4	
Combinations involving 9........	9–1–5	9–2–4		

Now let us see how these combinations can help us. Look again at the diagram. If both the cross and both the diagonal rows *must* add to 15, then the figure that we put in the center, common to all the directions, must evidently be a figure that is common to four combinations—and the only figure we have like that is 5; it goes in four of our combinations, no more and no less. So let us try putting 5 in the center.

Now, the question comes up: How arrange the four combinations in which 5 occurs? Let us try "1" in one corner and "9" in another. No, that won't work, because both "1" and "9" occur only in two combinations, whereas the corner square enters into three combinations. "1" and "9" must go in "side" squares. We have then 1–5–9 in the middle row. That forces the combination 6–1–8 into the first column. The rest is easy. Add the rows in every direction and 15 is obtained in each case, proving the answer to be correct.

Here we had the analyzing of the difficulty and the raising of assumptions going on hand in hand. This was quickly fol-

lowed by the third stage of testing out the assumptions to see whether they are correct. All this looks easy, but very few ever solve this puzzle except by trial-and-error methods. Let us consider the three processes involved in finding a solution in more detail.

2(a). *Analyzing the Difficulty.*—This depends upon previous experience with the elements which make up the problem. A botanist readily notes the relationship of stamens to calyx in a flower—a matter entirely overlooked by others not so trained. Similarly, a woman notes every detail in a menu because she is constantly dealing with menus. A man can hardly tell afterwards what he had to eat, because such details never concern him. After one has been taught to analyze many kinds of problems he develops general habits of analysis. That is, he knows that analysis should be made. So he hunts around for ways of breaking up a whole problem into its parts. But if he doesn't know anything about the material he will analyze in a very poor manner, just as early botanists classified plants in terms of characteristics of the plant instead of in terms of the flower.

2(b). *Stating the Problem.*—The tendency on the part of all is to strive for the solution, and to accept any solution that brings satisfaction. Hence, it is only the well-trained thinker who stops at this stage of solving a difficulty and forces himself to state just what it is that he is trying to solve. But unless this is done, the solution is most likely to be inadequate. All this is shown clearly in the case of children. They may start out in the right direction, but very soon they are proceeding in an utterly ridiculous manner because they are no longer responding to the real problem, but only to the latest step in the process. Hence the necessity of calling upon them to state the problem again and again.

2(c). *Raising Assumptions.*—While I was driving my automobile along a country road the wheels suddenly skidded just enough to turn the car at a right angle to the road. By the time I was able to stop it the front wheels had run off the edge of the road and were pointing down a steep incline. My companion and I got out of the car and walked about surveying the situation. Our first reasoned reaction was that it would wreck the car if it went down the steep incline to the level pasture below. This conclusion was an assumption. Now, in terms of it just as much as in terms of

the actual situation itself, the further reactions were made. After trying a number of plans which all proved ineffectual in getting the machine back on the road, we finally questioned the assumption itself. After a careful survey we decided that by going very slowly it would be possible to get the car down the steep incline (our second assumption). Once reaching the pasture it was clear that we could get back on the road at a point farther along. This plan was carried out and we went on our way.

Our first assumption was incorrect, and as long as we held it in mind we probably never would have got the car free without assistance. With a change of assumption we freed ourselves from the difficulty.

Sherlock Holmes was always preaching to Watson the necessity of distinguishing between the facts and the assumptions based on the facts. The trouble with most of us is that we do not question our assumptions but accept them as true. This is strikingly illustrated in the case of most students in trying to solve the puzzle given in the last lesson. They think of it as similar to checkers (an assumption, and one that ought to be challenged). So they try to solve the puzzle, moving a checker first on one side and then on the other. But the key move is the third move, made with a checker of the same side as in the second move. This they fail to see because of their false assumption.

Reasoning involves, then, raising assumptions and testing them out. It should be borne in mind that we must not only test out all the various reactions (solutions) that come to mind, but also must deliberately ask ourselves, what is the assumption upon which I am basing my solutions? Is it correct? In the case of a problem with five significant details, we should not permit ourselves to center all our efforts on trying out the associations aroused by considering one of these details, but should consider each detail in turn. Possibly the key association (the solution) will come to mind only after considering the fifth detail; possibly it will come to mind only when all five are considered together, or possibly when only the second and fifth are considered. In reasoning, then, one must not allow himself to concentrate all his efforts on one assumption, but must vary the assumptions. Ruger[1] reports a case where an individual worked

[1] H. A. Ruger, *The Psychology of Efficiency*, 1910, p. 31.

3600 seconds chiefly at one point in a puzzle. "He was then asked to state his assumptions. He did so, stating that he was trying to pass the ring over the end of the central loop and so off. (The ring came off, not there, however, but at a hinge on the side of the figure.) He was asked to change his assumption. After 480 seconds more, he was asked what he was doing. He replied, rather sheepishly, that he was still working along the same line. He was then asked to state what other possible ways of solution there might be. He mentioned the correct one: 'Well, it is just possible that the ring could come off at the hinges.' He could not seem to bring himself, however, to test the second hypothesis in any thorough-going way."

As we shall see later, in Lesson 49, the more clearly we formulate our assumptions, the greater the chance there is for us to vary the steps in solving our problem and to utilize the experience in new situations later in life. In the mirror-drawing experiment we developed our technique to a very large degree without consciously knowing what we were doing. Only after we had practically mastered the process did we come to understand what we were doing, if indeed we understood it then. There we could learn in that way because we had the two red lines constantly telling us whether our moves were correct or not. In the case of a puzzle we have no such guide (and this is true of the big problems of life). Not until the puzzle is solved (or, in life, not until years afterward) do we know whether the separate moves were correct. Hence, the more clearly we get before us just what each assumption really means, the better we are prepared for deciding on the appropriate move to make.

What determines what move will be made? In this elementary course, we cannot deal with such an involved question except to say that, other things being equal, that move will occur which is most in harmony with all the others, and in keeping with the sum total of our experience. The ability to pick out the significant details in the difficulty, and to infer the solution, has been called *sagacity*. A sufficiently sagacious person would perceive the assumptions given in connection with solving the puzzle on page 318, or the one in Lesson 38. Few have so much of this desirable capacity.

Many a scientist has had the data which pointed toward a new principle but has not seen that principle because it did not fit in

with his other experiences. But once the principle is enunciated by another, his old data are immediately interpreted properly. Similarly, we shall make mistakes in attempting to solve a new problem just in proportion as the correct answer is foreign to our experiences. The wider, then, our experiences, the more varied they are, the more likely we will be to solve our difficulties wisely and well.

3. **Trying out the solution** is the third stage in solving a difficulty. Certain aspects of this have already been pointed out. The most important point to note is that the mental trying-out is in terms of those associations that come into mind at the time. A little child living in New York City will not question the statement that one pumps milk out of a cow with the cow's tail, for he has no experiences that bear on the incident. Similarly, true and false assumptions are accepted or not depending upon the experiences that flash into mind at the time. Rear-Admiral Bradley A. Fiske in his recent book, *The Navy as a Fighting Machine*, expresses this idea when he says, "It must be borne in mind that in actual life our only real guide to wise action in any contingency that may arise is a memory, more or less consciously realized, of how a similar contingency has been met, successfully or unsuccessfully, in the past. Perhaps most of us do not realize that it is not so much experience that guides us as our memory of experiences. Therefore, in the training of both officers and enlisted men in strategy, tactics, seamanship, gunnery, engineering, and the rest, the memory of how they, or someone else, did this well and that badly (even if the memory be hardly conscious), is the immediate agency for bringing about improvement."

Thorndike[1] has the same thing in mind when he says, "A good definition of intellectual independence is '*reasoned dependence.*' The truly initiating mind does not imitate less, but more. It imitates more men, in more fields, in a greater variety of conditions. But here again it is reasoned imitation; and out of multifarious reasoned imitatings, comes, to him who has the capacity, the insight to discern, and the zeal to take, the profitable risk, the hopeful leap in the dark, the courageous step upward where no foothold may be found."

Analyzing the difficulty, getting assumptions and trying them

[1] E. L. Thorndike, "Education for Initiative and Originality," *Teachers College Record*, Nov., 1916, p. 408ff.

out are processes which all depend upon *knowledge*, upon the storehouse of existing habits. The more one knows the better the possibilities are of thinking out new solutions. But without sagacity, which apparently is a native capacity, the correct analyses will not likely be made nor the correct assumptions come to mind.

4. Satisfaction.—In the case of problems in which real reasoning is employed, the solution is not accepted nor rejected in terms of simple satisfaction or dissatisfaction as in the case of solutions worked out on the first and second levels. But the less truly logical the reasoning, the more will satisfaction and dissatisfaction enter to determine the acceptance of the solution. We all know good students and capable employes who can give us only such conclusions as they think their teacher or executive believes in. Here the desire to secure approval is too strong and the solution is accepted almost entirely on that basis.

5. Acceptance of a solution is made on the basis of belief or proof. *Belief* comes immediately and is not analyzed. It "seems to be an expression of the harmony of a particular statement with the dominant group of experiences . . . In the dream, where we may assume that large areas of the cortex are inactive and only the remaining few control consciousness, one will believe many constructions that are rejected as soon as one wakes. In the one case the dream need harmonize only with the partial consciousness, but as soon as one wakes, it is necessary that it harmonize with all portions. This it fails to do and is at once seen to be bizarre . . . In general, belief is agreement between the construction of the moment and the total experience."[1]

Proof is necessary when the individual does not entirely believe his conclusion, or questions whether another will accept it. Proof is expressed in terms of reasons. The conclusion is shown to be true because capable of classification under an already accepted law or principle or common experience. Thus we may prove that a whale is an animal and not a fish by stating that it is warm-blooded and breathes air in lungs. This is deductive proof. The other form of proof is inductive; by this form the solution is proved true because all other similar incidents were true. As Pillsbury expresses it, "The whole proof is one of

[1] W. B. Pillsbury, *The Fundamentals of Psychology*, 1916, p. 409ff.

assuming that what has happened will happen." Thus, the reader accepts the general characteristics of learning curves as true of all learning because these characteristics have appeared in all the curves studied.

Having scrutinized a solution from many angles one tends to accept it finally on the basis of proof, i.e., on the basis of reasons logically worked out. More often it is accepted in terms of belief, i. e., the solution seems to fit in with all the experiences that come to mind and moreover gives complete satisfaction. The writer knows of more than one research that has never been published—although it satisfies every requirement that the investigator can set up—because it gives results he does not believe in, or cannot reconcile with some generally accepted law. The results in such a research may have been proved correct from every angle now known, but because they are not believed, they are not accepted. On the other hand, proof is usually better than belief because it is based on reasons, logically tested, rather than on our own experiences and what we want and do not want.

Much of education is for the purpose of training individuals to solve difficulties on the third level instead of on the other two, and to accept solutions on the basis of proofs instead of satisfaction or belief. The insistence in writing up laboratory notes that the problem, method, results, interpretation, and application, shall all be distinguished is for the purpose of making the student think clearly and reason out his solutions. In such cases the problem is supplied; the student analyzes it, using various methods, and gets certain detailed facts (data) about it. Then these data are interpreted in terms of hypotheses that occur to the student, and as the interpretations occur he accepts or rejects them in terms of all the facts he has at his disposal.

Relationship Between Learning Through Trial-and-error and Reasoning

From our experience with the puzzle in Lesson 38, it is clear that this new situation is responded to primarily by random movements. We try this and we try that. Many undoubtedly learn to solve the puzzle through random movements alone. They employ actually no other process than that of trying and trying, slowly eliminating false movements and as slowly adopt-

ing correct movements. This is solving a difficulty on the first level. As an example of the other extreme of learning, on the third level, we may picture an individual who quietly thought out the whole solution before beginning to manipulate the parts, and then went ahead and solved it correctly in terms of his thought-out solution. Such cases are very, very rare. A less extreme case would be the individual who made each move only after a careful analysis of the entire situation, each time planning out what was to be done next, and so proceeded until he had solved the task without being forced to retrace a step. Such cases are not so rare, but are certainly seldom found. Between these two cases—one thoughtful planning and the other mere animal learning—lie all sorts of combinations of the two. Some persons will manipulate a very great deal and think out very little; others will do the reverse. The average person will probably first attempt to solve the puzzle by manipulation and only after many failures will he actually do any real thinking.

The total picture as to how difficulties are solved is this: The natural thing is to solve them on the first level. But many problems cannot be solved on that level. After many failures we shall use more and more of the processes outlined in levels two and three, but we shall be ever prone to get back to the first level whenever we can. The only assurance of adequate solving of difficulties lies in third level performance; but this level will not be reached until after we have been taught rigorous methods of thinking, and even then only when solutions cannot be obtained otherwise.

Wherein is the difference between the manipulative type of learning and the thinking sort? First of all, it is clear that they are alike in this respect, that both involve learning through trial-and-error—the former by trial-and-error of actual movements, the latter by trial-and-error of ideas. For even the rare individual who thinks the whole solution out before making a move thinks over many a possible move and discards it as wrong before finally seizing on the correct series of moves to make. As we have seen so many times before, a new situation demanding responses which are not called up by that situation is always reacted to by random movements, either actual or incipient. The difference between these two extreme types of learning does not, then, lie in the fact that one is a haphazard attack on the

[illegible] present situation [illegible] experience; [illegible] rehearsed, [illegible] situation judged [illegible] to "thinking out [illegible] or before, actually [illegible] while perfectly within [illegible] in cases similar [illegible] the prolonged suspension [illegible] is disagreeable to most [illegible] permits of immediate reaction [illegible] have the character of general [illegible] of the present case could be [illegible] thoroughly and surely mastered

in advance of motor reaction. Such a use of ideas occurs in specially trained human individuals within the range of their specialty, but otherwise is probably rare, at least in any complete form."[1]

Thinking implies bringing to the actual situation many associated ideas which then become an integral part of the total situation to which the individual reacts. The "random-movement" learner accordingly reacts to the actual single situation before him; the "reasoning" learner reacts to a more complex situation created by recalling previous experiences.

The Difference Between the Reasoning of Adults and Children

In some quarters we have heard that children do not reason until such-and-such an age, as for example, 10 years. Such a point of view is all wrong. The mental processes of children are in no way different from those of adults as to kind, although they do differ in complexity. The little girl of 3¾ years, who, after having had her tonsils removed, asked, "Why did God put tonsils in me if the doctor has to take them out?" has reasoned just as surely as any scientist or statesman. She has associated with the situation—tonsils removed—the memory of her grandmother's teaching that God made her, and has reacted to both details.

In Lesson 12 we saw that children have a smaller memory-span than adults. That means that they cannot hold so many items in mind at one time, i. e., that in reasoning they will not be able to react at the same time to so many details as an adult. Their reasoning, then, will be based on fewer items. And second, we realize that they have not had time to develop very many bonds, and therefore situations cannot call up many ideas. Consequently again, their reasoning must operate in terms of fewer units. These differences were clearly exemplified in an incident in which children's reasoning was contrasted with that of an adult. One bitter cold night, when there were several inches of snow on the ground, M. (aged 4¼ years) began talking of summer experiences, mentioning how, as she and her brother stood on

[1] G. T. Ladd and R. S. Woodworth, *Physiological Psychology*, 1911, p. 553f.

the porch steps, I had sprinkled their feet with the garden hose. I suggested that we do it again right then. E. (aged 2¾ years) assented with great glee and started for the front porch. M., however, expostulated (1) that it was too dark, whereupon I suggested turning on the porch light, and (2) that the hose was not out in the yard, whereupon I said I would go and get it from the attic. She still protested, but with no further argument. Her mother then suggested that it was too cold. With this new point in mind M. pointed out one detail after another against the plan, all centering around the idea "too cold." E., was not disturbed by all these arguments, but still insisted on having his legs sprinkled. Even after being taken out on the porch he was not dismayed, but was all eagerness to remove his shoes and stockings. In this case E. was not reasoning at all, though he did in other circumstances and had for some time. M., on the other hand, clearly called up two hypotheses, in terms of which she argued, and utilized equally well a third supplied by her mother.

The reasoning of children is, then, carried on with fewer units because of a small memory-span and of limited experience. The conclusions reached do not often agree with those of an adult because the reasoning has not been based on certain ideas that the adult has had in mind. Sometimes it is more accurate than that of the adult just because the latter has supplied hypotheses which were not germane to the problem and has reached a conclusion thus based on a wrong assortment of ideas; whereas the child, who is free from the hypotheses, has reached the correct solution. Possibly no one reasons more correctly about simple everyday affairs than does a boy of ten years, just because at that age he is rather free from the larger hypotheses governing life which adults have gathered together. The girl is much more likely than he to see facts through day dreams.[1]

Summary

Solving a difficulty, not previously encountered, necessitates (1) a motive, or desire, or want to solve it; (2) trial-and-error manipulation of the available supply of movements and associations; and (3) sagacity in choosing the correct ones from among

[1] Hans Gross, *Criminal Psychology*, 1897, translated by H. M. Kallen, 1911, page 366.

the entire supply. A situation is a difficulty only when it has been identified as the cause of dissatisfaction; and it is solved when dissatisfaction has been transformed into satisfaction.

Usually the solving process is neither clearly nor consciously comprehended. When a satisfactory state is not reached through ordinary random-movement learning the difficulty tends to become more and more clearly comprehended until it is spoken of as a problem. The process of solving a problem is called reasoning. Reasoning is a trial-and-error performance, but it involves a manipulation of ideas rather than of actual movements. The ideas that come to mind and the manipulation of them depend upon ideas previously experienced that are related in some way to the problem, and also upon the sagacity of the reasoner.

LESSON 40

HOW TO INFLUENCE OTHERS—IMITATION

The next few lessons will deal with the problem so often expressed as, "How can I get attention?" So far as the purposes of this course are concerned, we may define the term "paying attention to" by the phrase "reacting to." The teacher's problem, "How can I get attention?" is, then, "How can I get my pupils to react?" Really it means, "How can I get my pupils to react as I want them to do?" Except in abnormal conditions the teacher's problem is never, "How can I get attention?" but "How can I get attention to the thing I am presenting?" When Willie is throwing spit-balls at Fred he is attending to that matter, —he is reacting to the situation of Fred's proximity and spit-balls. But no teacher would call this "attention." What is "attention" from the standpoint of the teacher comprises a reaction by Willie to Mary's recitation of a geography lesson. Possibly if the teacher were to attempt to answer the question, "Just what reaction do I want Willie to make to Mary's recitation?" much of the trouble she has in "getting attention" would disappear. It would disappear, because the teacher would realize that generally there is no particular reaction for Willie to make. Her problem then would be to arrange the conduct of the classroom so as to present a situation to which Willie can react.

One of the ways in which this may be done is by demonstrating or showing what is desired. The pupil *imitates,* we say, and so learns.

The problem in this particular lesson is to determine whether one learns through imitation or not. Some psychologists claim that we cannot learn in this way. What is meant by such a statement?

Determine whether one can learn through imitation or not after answering the questions that follow.

As an aid in solving the main problem, define very carefully the two terms "learning" and "imitation."

In writing up your paper do not answer these questions in serial order. Present a well-rounded answer to the problem and utilize these and other cases in your argument.

1. If A smiles at us, do we smile back? (Consider A as a pretty baby; a disreputable old tramp (a) on the street, (b) as a comedian in a show; an old friend; a social leader; a negro waiter; a charming girl.)

2. If B shows great pleasure, do we likwise show pleasure? (Consider B as representative of various persons and enjoying pleasure for various reasons.)

3. How does a child learn to speak English in America, or Japanese in Japan, if not by imitation?

4. If we see another drinking at a bubble fountain, do we drink also? Explain.

5. When Mr. C and Mr. D meet Miss E whom only C knows, both C and D raise their hats. Does D raise his hat through imitation of C? If not, why not?

6. Do we learn to dance, or swim, or skate, or play tennis, or golf, through imitation? If not, how do we learn?

7. How are styles adopted so rapidly except through imitation?

8. Can a young woman copy her friend's way of doing up her hair? Isn't that imitation? Why couldn't she, when four years of age, copy her older sister's manner of braiding her hair?

9. After watching a man use a typewriter, or play the piano, or play chess, why cannot we do likewise? Or can we?

10. Are not all household tasks such as cooking, waiting on table, sweeping, dusting, etc., learned through imitation? If not, could they be learned through imitation?

(Hand in your paper at the next class hour.)

LESSON 41

HOW TO INFLUENCE OTHERS—SUGGESTION

Getting others to want to do what we want them to do is the most important psychological problem in teaching. For if pupils really want to get their lessons they will get them, provided some sort of instruction is given, whereas if they don't want to, the best methods will avail little. Getting interest, or arousing the desire to do the school work, is the problem before us.

The teacher often expresses this problem as that of *getting attention*. Let us first explore this conception of getting attention and see what it means.

Nature of Attention and Interest

Three Forms of Attention.—An individual in responding to a stimulus may give *involuntary attention*, *spontaneous attention*, or *voluntary attention*. The first two have already been considered in Lesson 31. Involuntary attention occurs when a stimulus is able to force a response. A loud bang, a mosquito bite, a pronounced rhythm, a pin projecting from the shoe of the boy behind one in school—all force attention, force us to respond to them whether we want to or not. If after the first response has been involuntarily made, we continue to respond with interest to the stimulus, our attention is then spontaneous and no longer involuntary. But if after the first response we do not want to continue responding to the stimulus, it is then viewed as a distraction and we endeavor to pay voluntary attention to something else.

Spontaneous attention is present either when the stimulus that is being reacted to leads to a response that satisfies an existing want, or when we are "hunting" for a stimulus that will lead to a satisfying response. It is the most efficient type of attention and is accompanied by the mental states of interest or satisfaction.

Voluntary attention arises under two conditions, similar in that each involves a conflict. In the first case we have an

individual exhibiting voluntary attention when he forces himself to continue reacting to certain stimuli in spite of the presence of other distracting stimuli. In the second case, voluntary attention is displayed when he responds in terms of that want (from among two or more wants) which is less immediately satisfying. So, if Fred wants both to watch Willie's antics and to study his geography lesson, we speak of his attention to the geography lesson as voluntary attention, whereas his attention to Willie is called spontaneous attention. To watch Willie brings immediate satisfaction, whereas to study the geography lesson will bring satisfaction later on when the well-prepared lesson is commended. A characteristic aspect of voluntary attention is the feeling of *effort* that accompanies it. Fred has to force himself to pay attention to the geography lesson because of the distracting antics of Willie.

Concentration of Attention.—Due to the fact that stimuli are nearly always present to distract one from what he wants to do, to satisfy certain wants when the individual is attempting to satisfy entirely different wants, it is necessary to cultivate voluntary attention. In other words, it is necessary to learn to concentrate one's attention on certain stimuli and to disregard other stimuli. This ability to concentrate grows chiefly out of cultivating the habit of ignoring other things. The little child reacts consciously to cutaneous sensations from his toes, to kinaesthetic sensations from arms or legs, to auditory sensations, to visual sensations, etc., sensations to which adults do not consciously react, at least ordinarily. Thorndike[1] expresses it thus:—"Such bonds as, 'Stimuli to hunger save at mealtimes—neglect them,' 'Sounds of boys at play save at playtime—neglect them,' 'Ideas of lying down and closing one's eyes save at bedtime—neglect them,' and the like, are the main elements of real fact meant by 'power of attention,' or 'concentration,' or 'strength of will'." The child must learn to form hundreds of specific detailed habits if he is ever to study as he should. He must learn not to pay attention to sensations from his toes; not to pay attention to moving objects, or in fact to any object except the book; not to react to noises in the room, such as a neighbor's pen or a whispered conversation, or to noises outside; not to react to hunger or thirst stimuli, etc.

[1] E. L. Thorndike, *Educational Psychology*, 1913, Vol. II, p. 419.

One goal to be reached in studying is the ability to concentrate on one's work, even when it is uninteresting. But such concentrated voluntary attention is still inferior in its efficiency to spontaneous attention, which arises when one is completely interested in what one is doing. The ultimate goal is to transform uninteresting work into interesting material.

Nature of Interest.—Interest is an accompaniment of spontaneous attention under certain circumstances. When performing routine affairs, like washing our hands, we give very little spontaneous attention and have very little interest. But when we must wait to wash, as in a Pullman car, we give spontaneous attention and are interested in what is going on. And if the waiting continues too long, there is again no interest, but rather irritation and dissatisfaction. In other words, interest seems to be manifested when there is a delay (not too long) in accomplishing what one wants to do. Consider another example. If we stop eating a beefsteak and consider the matter, we experience interest in the beefsteak. Or we have interest in it when we cook it, or when we think about it for dinner. But while we are actually eating it, we experience satisfaction chiefly—hardly interest. If it is then taken away, we are interested again, but no longer satisfied.

Another characteristic of interest is that it seems to attach itself to the object or idea to which we are reacting. It is *we* who are paying attention; it is the *object* that is or is not interesting; it is the *reaction* that is or is not satisfying. So we say, "This is an interesting book—I like (am satisfied) to read it."

One of the most common causes of interest is, then, some interfering element which delays the reaction temporarily. Truly, much of the interest in life comes in the anticipation of what is going to be done. Another cause of interest is novelty. In Lesson 33 it was pointed out that curiosity is aroused by novelty, by a new combination of old familiar things. Herein interest and curiosity are almost the same thing. The two terms refer, however, to different mental states. When we are interested we are attending to the object as an object to which our general response has already been defined. When we are curious, on the other hand, we are attending to the object while still wondering what to do with it. Curiosity appears when the new combination is too new to be immediately classified and reacted

to; interest appears when the newness forces only a slight readjustment in a response already started. The first time we listen to music broadcast over a wireless telephone, we are curious, but after several such experiences, the novelty wears off, we are no longer curious, and we may or may not be interested, depending upon how much we enjoy that sort of entertainment.

Getting interest in the schoolroom means presenting situations to which the children want to respond. But it means in addition that the situation must be frequently changed somewhat, so that the element of newness will reappear continually. A considerable change causes wonder, but not necessarily a desirable response. A still greater change leads to a situation so unfamiliar that the child will not respond, and will not pay attention, or will say "I can't do that," or "I don't understand." For instance, you try to answer the child's question, "Why does a street-car spill sand on the track?" You explain that is it to keep the car from slipping. That is understood. Then you seize the opportunity to explain the air-brake system. The child looks at you with mouth open in curiosity for a moment, and then his attention wanders off to something else. He cannot help it; he cannot react to the really new elements about air-brakes. (Of course, a very skilful development of the subject might keep him interested.)

Two schools of thought[1] have maintained opposite points of view with respect to the emphasis to be placed upon interest in schoolwork. One has maintained that children should be kept interested—that they should not be made to do what they don't want to do. The other school has emphasized the disciplinary view—that children should be made to do certain things just because they are hard and disagreeable for a child to do.

Discussion of this latter opinion will be reserved for Lesson 47. The modern kindergarten is a very good illustration of the practical working-out of the interest doctrine. Little children are there led to do what the teacher wishes them to do by being led first of all to want to do those very things. This method necessitates thought, time, skilful planning, and wide understanding. But when it is well carried out it is likely to be successful. The real educator is primarily concerned, then, in arousing interest, in making the students want to study.

[1] A standard reference is J. Dewey, *Interest and Effort*, 1913.

Three Methods of Influencing Another

By influencing another we mean getting him to do something which we desire him to do. Usually this means getting him to act immediately, but sometimes it means developing a certain view of life so that he will act in accordance with that view years later. The latter is accomplished through developing specific habits or general sentiments.

Three methods of influencing another can be distinguished, depending upon whether (1) he strongly feels a want that can be satisfied through doing what is desired of him, (2) he only slightly feels a want that can be so satisfied, and (3) he is not conscious of a want that will be satisfied by acting as desired. For example, consider three boys all perfectly able to do their arithmetic lesson in creditable manner. The *first* boy has a strong desire to lead the class. As soon as the lesson is assigned he goes to work. The *second* boy isn't concerned about leadership in this sense. But after the teacher has suggested the pleasure of beating all the rest, he attacks his lesson with zeal. The *third* boy doesn't want to lead, after it is suggested, and doesn't try. A note from the teacher to the third boy's parents, to the effect that a little encouragement would help, results in the father's offering a dollar if the son gets 100 in arithmetic for the week. So this boy eventually goes to work, not because he wants to do the arithmetic, but because he wants the dollar in order to buy a knife. The want to lead was present in the first case and the assignment was instantly tackled as a means to the desired end; in the second case the more or less dormant want was intensified and then the boy started studying hard; in the third case an unrelated want was utilized by connecting it up to the work to be done. To repeat: In the first case, the presentation of the stimulus leads to the desired response, without reference to any want at all; in the second case, the stimulus is presented and a related want suggested; and in the third case, the stimulus is presented and an unrelated want is aroused and related to the stimulus. (The terms related and unrelated refer to what is present in the mind of the individual to be influenced. For example, if the father of the third boy had offered the knife a day before, then the boy would have immediately responded as soon as the lesson was assigned. In

that case, the want of a knife would be viewed as related to the stimulus.)

1. Want Ready: A Related Stimulus Presented.—In the first case, the individual recognizes immediately that what is presented to him is an adequate way of satisfying an already active want. Naturally he acts as desired, and he does it wholeheartedly and thoroughly, with spontaneous attention.

Most work in school and elsewhere is performed on this basis. This is so because a great many of the children's natural wants are constantly being aroused in school; and school assignments, just because they are prominently before the child, are seized upon as ways of satisfying the wants. The desires to be noticed, to be approved of, to be a leader, and to follow the teacher and brighter or older children can all be satisfied more or less by doing the lesson. The desire to escape disapproval from teacher, fellow-pupils and parents, and the fear of punishment, also operate to accomplish the same end. The want to notice objects and manipulate them and the desire to mentally manipulate ideas are also there and aid very directly. Just how strong they are can be roughly appreciated by counting the large number of children who play school at home.

The educational problem in this connection is the problem of presenting school work so as to fit in with existing wants. This requires that the teacher shall understand the instinctive and acquired wants of children as they are found in a particular class. For these furnish the starting-point. Also it necessitates organizing the material in the course of study and in each lesson to fit in with the children's wants. (Certain exceptions to this rule will be discussed later.)

2. Want Suggested: a Related Stimulus Presented—Suggestion.—In the preceding section the discussion centered about "getting action" by presenting a situation to which the individual wanted to respond. In this section the discussion centers about "getting action" when it is necessary to do two things: first, suggest a want; and second, present a situation to which the individual will want to respond as desired. An illustration of this was overheard in a second-grade class: "Here are some pretty gold stars. I'll put one on every paper that is perfect. You have just ten minutes to study your spelling lesson. Let's see how many can get a star." A want is suggested—a gold

star—and the way to get it is to do what the teacher desires. A more complex illustration is given in Lesson 1, where Dr. Linder acted as though he had a revolver (creating a want to escape from being shot) and thereby made the crowd let him alone.

In suggestion, the emphasis is put not upon the response that is desired, but upon a situation which leads to the response. It leads to the response because within the individual there exists a bond connecting situation with response. The stronger the bond the greater the certainty that the suggestion will be effective. At a general clean-up day the students and the faculty of a certain college spent the day cleaning up the campus. They were organized into "gangs," and each was assigned a section of the grounds. At one point in the spirited cleaning-up that ensued, two women from one "gang," more or less as a joke, dumped a lot of rubbish on the section assigned to another "gang." No amount of entreaty availed to induce them to pick it up and dump it where it belonged. But—when the psychology instructor called out, "That will serve in tomorrow's class as a good illustration of sex-differences" (the topic assigned for discussion then)—they returned, picked up the trash, and went off with it, amid laughs and gibes. Why was the suggestion effectual? Because it presented to these women a situation with but one possible response. They could not allow the instructor (a man) to lord it over the women in the psychology class with the assertion that a woman cannot work so well or so fairly as a man. Now, the instructor did not make them carry the trash off—he did not even mention the matter. But he presented a situation which produced the desired response.

A florist advertised in the street-cars with a card bearing a picture of a beautiful spray of red roses and the question, "How long since you sent her some?" He didn't say, "Buy roses from me." He didn't talk about the response he desired. No, indeed. He presented a situation which he knew would force men to buy his flowers. And they bought them. As one said, "My wife nudged me with her elbow and looked at the card. What was there for me to do but buy? It's a 'hold-up' game!"

The easiest and also the most successful way to influence others is through suggestion. The other fellow does not feel "cornered" as he does when he is argued into doing anything. He doesn't

feel coerced, because the cause for his doing what was wanted lies in the strength of his associations—his own organism has forced him, not some outside agency.

Without question suggestion is intimately related to the instincts of submission and self-assertion. The more submissive one is to the person who is employing suggestion, the more effective is the suggestion; because the want to be submissive, having been aroused, naturally leads him to do whatever will bring approval. A few persons respond to suggestion by doing just the opposite (counter-suggestion). Such action is to be viewed as an expression of self-assertive activity, as distinguished from submissive activity.

An interesting use of deliberate suggestion in educational work is reported by Myers. Two paragraphs are quoted here. In developing the course of study and the texts which were used in the Americanization Schools of the Army "there was a conscious attempt to make the warp and woof of the Lessons a propaganda for that school, for more education by the soldier and his home folks, for the Army, for the United States Government, and for America and American ideals. It was assumed that all suggestions of proper habits and virtues are most effective when camouflaged, and especially when the learner unwittingly becomes the teacher of those duties and ideals which it is desired he shall get. In the Lessons the learner is not told that he should sleep with his windows open, that he should brush his teeth and clothes, stand erect, sit erect, take care of his appearance, and respect the great men and the flag of his country. Instead the learner becomes the reader or the writer of a letter to a friend in which he tells that he has developed these desirable traits, attitudes, and virtues, and suggests indirectly or directly to this friend that the latter could do the same and attain the same virtues and attributes. Throughout, the learner suggests the very virtues to himself which he seems to be suggesting to his friends. The first lessons of the course aim to 'sell' the course and the school to the learner; to suggest to him that he wants to learn and why he wants to learn. The first sentence he reads is, 'I want to learn English' and the fifth is, 'I want to learn to write a letter home.'

"In his ninth lesson, which is a letter to his mother, he reads:

Co. C., Recruit Educational Center
Camp Upton, N. Y.
February 1, 1920.

My Dear Mother:

This is my first letter home. I am going to write you a letter every week. I got a long letter from Nellie. She said she saw you. The sergeant read it for me but her next letter I am going to read myself. I want to read a good book. It is a hard job to learn to read and write but a good soldier likes a hard job. I have a good captain. He is a friend to every soldier.

Robert Brown.

In these letters he suggests to himself that he is going to read the next letter from his sweetheart, that he is going to read a good book, that he is doing well a big job, and that his captain is his friend."[1]

Much has been written about suggestion and the state of suggestibility, apparently on the assumption that it is more or less an unusual or even an abnormal condition. The writer believes that man naturally accepts what he sees and hears as true, and acts accordingly, except in occasional cases where the mind recalls previous experiences that run counter to what is now being presented. This has already been pointed out in connection with the lesson on reasoning, where it was stated that man really thinks out the solutions to his difficulties only when forced to do so.

3. Want Aroused and Related to Stimulus—Motivation.—This third method of influencing another will be considered in the next two lessons.

Some readers may at this point raise the query, "Shouldn't one influence another through reasoning?" The ideal is undoubtedly to appeal only through reason. But man is actually influenced very largely by his native wants. And when intellectual appeals will not accomplish what is desired, more emotional appeals must be employed. The facts of the case seem to be that man must be both convinced intellectually that the suggested program is adequate and made emotionally desirous of acting in terms of the program.

Suggestion, Imitation, and Ideo-motor Action

We have assumed so far that a person can be led to action through suggestion. Discussion as to how far and why this is so

[1] C. E. and G. C. Myers, *The Language of America, Teachers' Manual*, 1921.

is usually presented under the two headings, *imitation* and *ideo-motor action*. As a preliminary, let us see how these two terms differ from the term *suggestion*. A suggestion may be made either by doing an act oneself or by presenting an idea which leads to the act. One may go and get a drink or one may talk about getting a drink. In either case one suggests the want for water, and action in others follows, depending upon the presence in them of thirst. Now when A gets a drink and B does likewise, A suggested to B, and B imitated A. Suggestion and imitation refer, then, to the same psychological process. In the case of suggestion the emphasis is upon presenting the situation; in the case of imitation, the emphasis is upon reacting to the situation. But if A does not get a drink but only talks about it, and then B goes and gets one, we have, technically speaking, not *imitation* on the part of B, but *ideo-motor action*.

Let us now consider, first, how far A can make B act through suggestion (or, put the other way about, how far B will imitate A); and, second, how far B is likely to put into action the ideas presented by A.

To What Extent Does One Learn Through Imitation?

Imitation is technically the doing of an act which someone else has been seen to do. A very hasty survey of the matter indicates that we certainly imitate some actions of another such as waving the hand in good-bye, and on the other hand, we cannot at the first trial imitate some other actions we observe, such as a fancy skating act. Our chief problem is not, then, "Do we imitate?" but rather "To what extent do we imitate?"

In considering this latter question, it is proper to realize *first*, that there are some actions of one person which instinctively cause the same actions in another. For example, the smile of a friend spontaneously provokes an answering smile on my lips. A man in a street-car chuckling over his paper will cause other passengers to grin sympathetically. Very frequently someone will begin to run as the crowd begins to come off the ferryboat, whereupon many quicken their pace. A man stopping on the street to look upward ostentatiously will soon have a crowd of sky-gazers around him. Many such examples of this sort of action can be presented, all going to show that to certain actions of another we instinctively respond by doing the same thing.

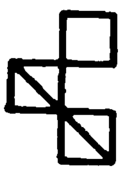
Second, it is necessary to realize that there are certain actions of one person which cause the same actions in another due to habit. After a good musical selection someone claps, and then many begin clapping. We have done this so often that there is a well-formed custom established of clapping when others clap. We have done here only what we have already learned to do.

Third, we must realize that there are certain actions of one person which set up standards, and the actions of another are then brought to conform to these standards through the resulting satisfaction of approval or dissatisfaction of disapproval (see Lesson 34). Thus, if a child asking for marmalade at the table says "marlid," no response may come from the parents. Another attempt is made—the child says "mamalade." This time the spoken word is close enough to the adult standard to be understood by the parent, and the desired response is obtained. As time goes on "marlid" will be spoken less and less and "mamalade" more and more. The nearer the spoken word is to the adult standard, the quicker is the parent's response.

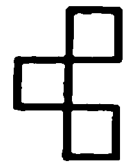
In the matter of learning to speak a language it should be borne in mind that the vocalization of the different sounds comes about through random movements and not through imitation. The parent's pronunciation is the standard which the child approaches as something like a geometrical limit. Once, however, the various sounds can be voluntarily given, i. e., are learned, then direct imitation may follow. But the case then falls under the second heading above. The child can imitate because he already has learned to reproduce each sound when he hears it.

In other cases a certain action is witnessed, such as blowing smoke-rings, or fixing the hair in a certain way. If the observer achieves the same results, it is said that he has imitated. Really, he may have performed the process in an entirely different fashion, but the two results are similar.

Fourth, we may actually perform new acts which we have never done before, after watching another do them. This is the aspect of imitation which it is worth while to understand in teaching. For example, if A goes to the board and draws this figure,



B can also go and draw it, although he has never drawn that particular figure before. B can do it, however, because he has already drawn squares and

diagonal lines. A's drawing consists of three squares and two diagonal lines in a certain relationship. As B has already learned to do the various parts, all that he needs to do is to remember the relationship of the parts. Whether B can draw what he has seen A draw becomes primarily a problem of primary memory, of memory-span. If he can remember (1) three squares, (2) two diagonals, (3) diagonals in last two squares, and (4) squares in this position  he can imitate A correctly. B then does nothing new in imitating A, but he reorganizes his old performances in a new way. The extent to which he can carry in his mind the parts and their relationship to one another, is the extent to which he can imitate A's performance.

This last example involves two factors; imitation and primary memory. From a practical standpoint imitation always involves primary memory, but they are distinct processes. As far as imitation itself is concerned, it is clear, from what has been said, that we can imitate another when we have already in our possession a bond connecting "perception of his act" with "a similar movement." In other words, we can imitate what we can do; we cannot imitate what we cannot do.

The laws of primary memory determine to what extent we can imitate. An adult can remember six to seven very familiar, simple items, four to five less familiar or more complex items, two to three rather unfamiliar or quite complex items, and only one very unfamiliar or very complex item, and not always that. In proportion to a child's mental age, the child can remember very little or as much as an adult. These laws of primary memory underlie our ability to imitate another's action when each part of that action is known to us but the relationship of the parts is new. Anyone to whom this matter is not clear should experiment on a friend and determine just how complicated figures he can look at and then reproduce. His ability in this line will be found to be determined strictly by the familiarity of the material (through permitting him to group simple items into more complex wholes) and his ability to retain the relationships between the parts. But if the performance contains a habit which the friend has not acquired, then he will fail to imitate. A new habit must be learned, as all habits are learned, either by random movements or by stimulus substitu-

tion. Take the case of learning to dance. If the learner has had no experience of a similar nature he must learn through random movements. The teacher can do very little here but present the separate movements one at a time and correct the random movements until they settle down to the correct moves. Such a learner could never imitate the whole performance of even a simple dance. The writer knows of a very skilful gymnast who learned several dances (never having danced before) in one afternoon. To him the various separate movements were all familiar, having been used in other stunts. And because they were very familiar, he could group the simple movements into complex groups and could also retain several of those complex groups in mind at one time. He was able to watch a dance performed and then repeat it with a fair degree of precision the first time.

Consider another case. A little child sees me screwing a screw into a hole. A few minutes later I find him with a screw-driver and a screw endeavoring to do what he has seen me do. He can hold a screw-driver because he has learned to do such things. He can also hold a screw for the same reason. But he fails in turning the screw-driver. Why? Because he has not learned how to make this complex movement of turning his wrist. If he could make this movement he could learn the whole process through imitation. But as we do not learn new movements through imitation, he fails. A year or so later, when he has learned through trial-and-error to make this wrist movement, he will see the process again and then will repeat it through imitation.

To What Extent Does One Learn Through Ideo-motor Action?

The most often quoted statement of ideo-motor action is that from James.[1] "We may lay it down for certain that every representation of a movement awakens in some degree the actual movement which is its object; and awakens it in a maximum degree whenever it is not kept from so doing by antagonistic representation present simultaneously to the mind." Whether one will accept this as true or not will depend on the interpreta-

[1] W. James, *Psychology*, 1893, Vol. II, p. 526.

tion given to its various phrases. A moment's introspection will convince one that the theory is well-founded at least. The thought of "walking" arouses in me now a sense of muscle activity in my limbs. The idea "eating candy" starts a muscle activity in the throat, and a slight salivation. The concept "dancing" may result in a feeling that the muscles are limbering up and that the body is better balanced than usual.

In all these cases the idea of the movement has awakened the movement, though only in an incipient degree. In appropriate situations the response is complete. Thus, when one is at the dinner table the thought "drinking" leads to the draining of one's tumbler. When one is tired, the thought of "sitting" leads one to seek a chair. And so on. The examples are obvious.

So, far, then, one must agree that the ideo-motor theory is correct. But it has its limitations, recognized indeed by its original formulator. For he said, "Every idea of a movement awakens in some degree the actual movement." As long as the emphasis remains on "*in some degree*," we accept the dictum. As soon as that qualification is forgotten, we must reject it.

For it seems perfectly plain that the idea of a movement that we cannot make can never awaken in us that movement in its entirety. We may have a clear idea of flying. We may get with that idea a fluttery sensation in the arm muscles, which is perhaps the movement of flying "in some degree." But we certainly can't fly.

In like manner, when we have not learned a possible movement through trial-and-error, merely having an idea of it will not enable us to make that movement. Thus we may have the whole theory of skating carefully worked out. We may even have roller-skated. But on our first try on the ice we shall bump our heads.

Here we may see the difficulties into which the too enthusiastic supporters of the ideo-motor theory have fallen. To contend, as they do, that new responses can be acquired simply by arousing ideas of them, is patently absurd. As in the case of imitation, we can make a movement only in response to an idea which is innately connected with it, or habitually associated. As Thorndike[1] puts it, "The idea of a movement is in and of itself, unable to produce it. I contend that an idea does not tend to provoke

[1] E. L. Thorndike, *Educational Psychology*, 1913, Vol. I, p. 177.

the act which it is an idea of, but only that which it connects with as a result of the laws of instinct, exercise, and effect."

The whole point of this course in psychology is to connect up situations with responses. Efficient remembering is dependent upon the fact that when a response is needed in life the situation to which it is tied will be present in life to call it up. To get attention is to present situations which have responses tied to them. Now to suppose, as the doctrine of ideo-motor action postulates, that we can get a response by simply presenting a situation which pictures it in some way is to deny the fundamental principles laid down here. No description in the world will give a man ability to high-jump, or to play chess, or to write a poem. The only way he can learn to do such things is to learn to do them by building up a complex group of habits, by the processes already discussed. Of course, what has just been stated does not mean that, if one obtains a new idea of a complex movement from reading, he can not go and execute that movement provided its details are already known and are associated with the given description. Here, only the relationship between the parts of the idea, or between the several movements, is new. Such a relationship can be obtained and carried into effect as we have seen.

Summary

To influence a person and get him to do what we desire is dependent, first, upon the existence of a bond connecting some situation with the desired response; and second, upon the presentation of the situation. When this is done, the response will follow, provided the person wants to so act. If he does not want to, a want can be suggested that will lead him to make the desired response. (In the next two lessons a third phase of this subject will be considered, in which it is necessary to do more than merely suggest a want.)

There are limitations to the successful use of suggestion. An individual *can* imitate or respond through ideo-motor action to the extent that he can do each part of the performance upon seeing it done and can retain in mind the combination of parts. An individual *will* imitate or not, depending upon the presence of a want to do so.

LESSON 42

HOW TO INFLUENCE OTHERS—MOTIVATION

By *suggestion* is meant that one person suggests to another some want that the second desires to have satisfied, and at the same time presents some situation, a response to which will satisfy the suggested want. So a member of a crowd gathered about a murdered man may utter some inflammatory denunciations of the murderer, arousing wants to injure him, and wind up his speech by saying "Get a rope." And away goes the mob.

But in using *motivation* one must do more than merely suggest an existing want; one must arouse a want. In the case cited, it is suggestion that is employed; the emotions of the crowd were already aroused. But, on the other hand, motivation would be used to stir up a perfectly peaceful-minded crowd to lynch someone. The most extreme examples of motivation are those to be found in some forms of propaganda, where months, and even years, are required before public opinion can be changed.

As a simple illustration of motivation, consider the advertisement in Plate XXXIX. This particular advertisement can be easily divided into four parts: (1) picture, (2) heading, (3) copy, and (4) coupon. "Now, how do these four parts affect a reader? Roughly we see that:

"1. The picture arouses certain wants. The more we look at it the more we think of home, of father and mother, and of what they have done for us. All this affects particularly the young man away from home.

"2. The heading intensifies these wants and adds another element to it—i. e., the thought of early ambitions on leaving home, survey of career, determination to make good, etc.

"3. The copy further intensifies all the wants and gradually directs the aroused activity toward a specific act.

"4. The coupon furnishes a specific outlet to all this aroused activity—i. e., to sign the coupon and mail it.

Plate XXXIX.—Illustrating Simple Motivation.

"Now consider in greater detail the rôle that each of the four parts plays:

"1. The picture appeals directly to the parental instinct (for love of parents is a modification of the instinct which makes us love our own children); also to some degree it appeals to the mastering and fighting instinct. And as the picture is studied, many of the richest and most familiar of childhood memories come to mind.

"2. The heading directly arouses the mastering and fighting instincts and further intensifies the parental instinct. We are expected to make good by our parents and we determine to do so.

"3. The copy starts out by stimulating further all these instinctive activities and then gradually presents a way in which all this activity may be worked out in a satisfactory manner.

"4. The coupon makes it extremely easy for us to make the first step in the desired direction."[1]

Expressing all this in other terms, we have:

First, *arousing wants*, i. e., to do something for mother and father, to make good, etc.

Second, *presenting a situation* which can be reacted to in terms of these wants, and, at the same time, leads to the response the advertiser hopes for. It should be noted that the more wants are aroused and the less they can be adequately expressed as responses to the situation presented, the less likely the individual will be to do as desired and the more likely he will be to do something else. So, after reading the advertisement, a young man may return to day school, or attend a night school, or go to college, or work harder in business, or start saving, or stop gambling, or take a course in some other correspondence school with which he is more familiar. But if the presented situation appeals as an appropriate one to respond to in terms of the aroused wants, the reader will sign the coupon and send it to this correspondence school.

Third, *making the desired action easy*.—Human beings hesitate to make a new move. Therefore, the easier it is for them to start the more likely it is that they will start. So a coupon secures more replies than the same advertisement without one.

Assignment.—1. Prepare an introduction to Lesson 8 which will motivate students so as to tackle that experiment with enthu-

[1] E. K. Strong, Jr., *Psychology of Selling Life Insurance*, 1922, p. 152ff.

siasm. Your introduction should not occupy more than three-fourths of a printed page.

2. State clearly just what wants you have attempted to arouse.

3. State clearly just what situation you have attempted to present which should afford a satisfying response on the part of students to the wants you have aroused.

LESSON 43

HOW TO INFLUENCE OTHERS—MOTIVATION (continued)

Four methods of getting another to do what is desired have been discussed. First, if there is no bond between a stimulus and a response, it must be developed through learning, as otherwise, when the stimulus is presented to an individual, he cannot make that response. In Lessons 40 and 41 it was shown that such bonds cannot be formed through imitation, although the reorganization of a system of bonds can result in that way. Second, if the bond is strong enough and if the individual wants to respond to a situation, then he will respond when the situation is presented. Third, if the bond is strong enough but the individual does not want to respond, in many cases he can be made to act by suggesting some appropriate want when the situation is encountered. It is because of the want that he acts, but it is because of the present stimulus that he makes the specific response desired. This method of getting another to do what one desires is called suggestion.

The fourth method of getting another to do what is desired is *motivation*. It differs from suggestion only in the respect that the want cannot be merely suggested, but must be more or less built up on the basis of instinctive wants.

Nature of Motivation

In Lesson 36 a sentiment was shown to be "a system of emotional tendencies centered about some object," or the association of an idea and a want (emotion). Suggestion and motivation may both be viewed as processes whereby a sentiment is deliberately developed—an idea and a want deliberately associated. But, as pointed out just above, in the case of suggestion the want can be easily aroused and associated with the desired action, whereas in the case of motivation the want cannot be so easily

aroused nor associated with the desired behavior. Also, in most cases of suggestion the sentiment is of a fleeting, transitory sort—a truly permanent sentiment does not result.

A very clear illustration of motivation has been given in connection with the International Correspondence School advertisement in the preceding lesson. Lesson I of this text is another example, presented by the author in order to get you, the reader, interested in doing the work of the course.

Consider another illustration of motivation taken from an actual case of selling a dentist an educational policy. (An educational policy is a form of life insurance whereby if the parent does not live the child will receive a certain amount on the first of September and of February for four years, commencing, say, at eighteen years of age, thereby guaranteeing the child's education. If the father lives, the policy continues like any other policy.) Dr. Barnes, the dentist, was very much interested in his alma mater and in his boy. He had a wife and two daughters, who are not provided for in this particular policy.

"After introducing himself, Bagley, the insurance salesman, says, 'I believe you have a son. Of course he's not old enough to go to college yet, is he?' ('Son' arouses parental instinct; 'college' arouses a very strong acquired interest.) Barnes replies with a laugh that the boy isn't old enough to go to college.

"Bagley next discusses college education. After some conversation he links college education with life insurance. The combination is a new idea to Barnes. Being new, he can't react to it. So he must reply in some such way as, 'I don't understand just what you mean.' Bagley then proceeds to explain the plan. As he demonstrates his proposition he also continues to arouse Barnes's instinctive and acquired interests. Note these phrases which have been picked out from the salestalk:

"'Educational policy insures your boy a college education.'

"'Scale of living to which you have accustomed your family—not sufficient income to support family, if you die, and send boy to college.'

"'You would feel happier to know that his college education was provided for.'

"'A high-spirited boy would probably hesitate to allow his mother to send him to college if it involved sacrifice on his mother's part.'

"'Working his way through college . . . a distinct handicap; studies suffer, no matter how conscientious and industrious he may be.'

"'About one father in five does not live long enough to see his boy through college.'

"'Doctor Kellar—his boy no longer at Taft School—going to college will be a source of some embarrassment to him and to his mother.' (Very indirect appeal to mastering instinct.)

"'Your boy . . . benefit of college . . . no sacrifice by mother . . . independent of anyone . . . college work will not suffer.'

"'Is there anything that would make him more appreciative of his father, anything that would more surely tend to keep alive in his heart all his life a deep affection and high regard for the memory of his father? The fact that his father had the foresight and the sense of responsibility and the love for him to provide for his college education would seem to him the most certain evidence of all that his father was the kind of father he had always believed him to be.' (Direct appeal to parental and mastering instincts, also indirect appeal to desire for approval, which Bagley is implying will or will not be given him according as he buys or not.)"[1]

Here, as in the case of the International Correspondence School advertisement, wants have been aroused (to send boy to college, to do something for boy, to protect wife and family, to secure approval); and a situation presented to which he can respond and thereby satisfy all these wants.

Motivation a Socially Useful or Dangerous Tool

Consider two other examples of motivation. The first one is reported in the Survey of November, 1919, as part of the speech of Mother Jones, who has always exerted a powerful influence over strikers.

"We're going to have a hell of a fight here, boys," she said. "We are to find out whether Pennsylvania belongs to Gary or to Uncle Sam. If it belongs to Gary we are going to take it away from him. We can scare and starve and lick the whole gang when we get ready . . . The eyes of the world are on us today. They want to see if America can make the fight . . . Our boys went over there. You were told to clean up the Kaiser. Well,

[1] E. K. Strong, Jr., *Psychology of Selling Life Insurance*, 1922, p. 163ff.

you did it. And now we're going to clean up the damned Kaiser at home . . . They sit up and smoke seventy-five cent cigars and have a lackey bring them champagne. They have stomachs two miles long and two miles wide, and we fill them . . . Remember when all was dark in Europe and Columbus said, 'I see a new land,' they laughed. But the Queen of Spain sold her jewels and Columbus went to it . . . He died in poverty, but he gave us this nation and you and I aren't going to let Gary take it from us . . . If he wants fourteen hours he can go in and work it himself . . . We don't want guns. We want to destroy guns. We want honest men to keep the peace. We want music and playgrounds and the things to make life worth while . . . Now, you fellows go on out. I want to talk to the other boys."

That sort of speech gets action. It is an example of motivation. But the use of motivation is not limited to such stump oratory. It is present in our highest examples of appeal. Consider the following:—

"Fourscore and seven years ago our fathers brought forth upon this continent a new nation, conceived in liberty, and dedicated to the proposition that all men are created equal.

"Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting-place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.

"But in a larger sense we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead, who struggled here, have consecrated it far above our poor power to add or detract. The world will little note nor long remember what we say here; but it can never forget what they did here. It is for us, the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us; that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion; that we here highly resolve that these dead shall not have have died in vain; that this nation, under God, shall have a new birth of freedom; and that government of

the people, by the people, and for the people, shall not perish from the earth."

Compare these two speeches, both of which arouse emotion. The former does so by direct appeals to the basic native wants of man, the latter by appeals to the loftiest sublimations of man's instinctive nature.

Before attempting to evaluate motivation, two further implications should be noted.. First of all, "any emotional element can be associated with any specific line of action. Practically, certain combinations are difficult to accomplish, but theoretically, they are possible. Thus, the correspondence school arouses the boy's love for his mother and challenges him to make her proud of him and 'funnels' the aroused emotional desire into taking a correspondence course. The same appeal could be utilized to get young men to go to church, to quit gambling, to work harder for their employers, to enlist when war is declared, to do anything the boy could be made to believe his mother would approve of."

Second, "No logical connection needs to exist between the emotion which is aroused and the program which is outlined. And further still, there need be no logical establishment of the fact that the program is really the best one to be pursued, or even that it is honestly conceived . . . The detailed suffering of a little girl and her kitten can motivate our hatred against the Germans, arouse our sympathy for the Armenians, make us enthusiastic for the Red Cross, or lead us to give money to support a home for cats. The story may be true or concocted for the purpose; the inferences against the Germans or for the home for cats may also be true or false; the organization carrying on the propaganda may be efficiently administered or not—all these considerations little concern us. We feel the emotion, we want to do something because by acting we will feel better, and away we go regardless of mere intellectual considerations."[1]

Today motivation, usually called propaganda when employed on a large scale, can be controlled in some respects. But such control is restricted very largely to punishment of those who state what is not true, as in dishonest advertising or libel. Society has not worked out methods of evaluating the use of emotion

[1] E. K. Strong, Jr., "Control of Propaganda as a Psychological Problem," *Scientific Monthly*, Mar., 1922.

and consequently can do little to control propaganda skillfully carried on. It is accordingly possible today for a group to carry on a very subtle propaganda with the immediate aim of developing some sentiment (public opinion of a certain sort) and only later on to secure action in terms of the sentiment. "So France mourned at the Strassburg statue in Paris each year and kept alive the sentiment to retake Alsace-Lorraine. Of course, we completely sympathize with her. But it made Germany prepare all the more for war, and the world sat back and looked on while Germany established the sentiment in the minds and hearts of her citizens that they lived only for the Fatherland and that was the truest expression of their country's life . . . The existence of a sentiment in Great Britain that treaties to which they were a party must be observed, was one important factor in forcing that nation into war with Germany when the latter violated the neutrality of Belgium. As Sir Edward Grey said, 'My God, what else could we do?'"[1] Because of the absence of an appropriate sentiment the United States did not declare war in 1914. During the next three years such a sentiment developed and was finally put into action in a calmer and far less emotional state of mind than usually prevails at the outbreak of war.

This condition is a challenge to society to find ways to cope with such fearfully complex problems. It also, at the same time, illustrates what may be accomplished by those who endeavor to build up socially worth-while sentiments. For through the agency of such sentiments much of society's advance is made.

Is there any way at all of evaluating motivation? Theoretically, yes; but practically, in a great many cases, no. The distinction between wants and needs, pointed out in Lesson 31, is of aid here. Motivation, aimed to accomplish what is not *needed* by an individual or by society, is undesirable; whereas that aimed to accomplish what is needed is desirable. Business men are more and more evaluating their sales programs in terms of service to the customer, which is another way of expressing the idea of need. Theoretically, then, we have a guide to the evaluation of motivation. But practically speaking in many cases it is just as difficult to determine what is needed by an individual, a group, or by society as a whole, as it is to evaluate the motivation itself. Patrick Henry's speech, for example, was

[1] E. K. Strong, Jr., *op. cit.*

good motivation from the standpoint of the Revolutionists, but not from the standpoint of English sympathizers.

Limitation of space makes it impossible to follow this interesting topic further. Suffice it to add, that one of the greatest problems of educators is to determine what are the most socially worth-while sentiments that man and woman must have and then to see to it that they are developed.

Motivation Needed in Public School

Teachers must needs motivate their work. There is no other way by which pupils will do disagreeable, difficult tasks which in themselves bring no satisfaction at the moment. All teachers motivate their work whether they know it or not, although some may and have used very little motive other than fear of punishment or dread of disapproval. The problem of motivation is then, first, how most skillfully to motivate the work and, second, how to develop the students so that higher and higher motives may be employed. The practical working-out of these two points belongs properly in the field of pedagogy. Enough has been presented here to enable the teacher to develop this matter for himself. If stock could be taken once a month of the motives one employs in his teaching, and the extent to which children respond to them, a teacher would soon know what sorts of motives he was employing and whether or not his students were steadily being trained in responding to higher and higher motives.

The study of Burke's speech on "Conciliation with America" is notoriously a difficult matter to teach in High School because it is so dry and uninteresting to the students. Apparently it has no prepotent elements within itself. The first step in teaching it should be, then, to supply some outside prepotent elements. Suppose that some time were spent at the start reviewing, first, the situation which existed between the Colonies and Great Britain, emphasizing the fighting aspect; and second, recounting a number of occasions in which a great speech has influenced a nation's destiny. Then drive home the facts that here was a man fighting for his country, just as much a fighter as Cornwallis or Howe; that possibly this speech played as large a part in the struggle between Great Britain and the colonies as many a battle. Next bring out how men fight with words instead of fists; and the extent to which this sort of fighting enters into the

government of the United States. Finally proceed to see how this man, Burke, fought. And then ignore a little the "appreciation" of similes and metaphors, and let the boys appreciate the speech in their own way—a way necessarily quite different from that of women, and especially here where the fighting instinct is uppermost. If this plan is carried out with any degree of enthusiasm, you will not need to worry about "attention." There will be plenty of reactions.

In addition to getting children to perform the intellectual tasks that are set them, and to come to do these tasks on a higher and higher motive basis, the educator must needs develop sentiments, or ideals, or abstract conceptions which will actually control conduct. In all such cases the individual is acting in terms not of immediate satisfaction but of remote satisfaction. Certain sentiments were discussed in Lesson 36 and should be reviewed at this point. Still other such "systems of ideas and emotions" may be noted here. Take the case of cleanliness. Apparently the only instincts toward cleanliness are the tendencies to lick the mouth when dirty and to keep the fingers free from sticky objects. It is certain that children show no further instinctive desires for cleanliness. Boys are notoriously lacking in any interest in cleanliness until the mating instinct awakens interest in their personal appearance. Nevertheless, cleanliness is today among most individuals one of the strongest acquired elements to which we react. This is due to the fact that cleanliness is widely emphasized and appreciated. So universal is it to be clean that the person with a dirty collar, an unshaven face, or untidy shoes, is immediately looked down upon as inferior. Just as it is important to train children to be clean, so it is essential that they be trained to react in terms of sentiments or ideals such as patriotism, honesty, persistency, truth, support of charity, "work for future success," etc. All such must be learned; they are not instinctive tendencies.

In this republic of ours it is absolutely essential that majority-rule shall be prepotent. Consider by how small a majority Wilson triumphed over Hughes! A Democratic plurality of 591,000 votes in a total of 18,500,000, a superiority of 23 electoral votes among 531. Consider also the prizes at stake. And how quickly the American public acquiesced in the results! There was not a suggestion of rebellion. Compare the conduct of the

American people in this respect with that of the Mexicans. In the one country majority-rule is a dominant sentiment. The slightest appeal to it results in a response to it. In Mexico this element is not dominant. Too often the minority have ruled. Too often a rebellion has been successful. An election there does not settle a controversy because just such sentiments are lacking, and in their place are elements leading to armed revolt.

Development of Ideals.—Bagley has expressed this matter very clearly in his chapter, "The Development of Ideals the Chief Work of Education."[1] The quotations that follow are from this chapter.

"It would probably be difficult to overestimate the importance of ideals in civilized life. They are the dominant forces in all the great movements of history. Races and nations are distinguished from one another by their ideals far more than by their inherent physical and mental peculiarities. In spite of the elements that foreign nations have contributed and are contributing to the American people, our nation is distinctly individual because it has its individual ideals. The German, the Celtic, the Slavic, and the Romance ingredients become indistinguishable after two generations because their distinctive race or national ideals have dropped and the American ideal has been assimilated. That the Jewish people still maintain their racial characteristics is due to the fact that their great ethnic ideals are cherished from generation to generation with a tenacity that no other people of history have even approximated.

"The *esprit de corps* that is expressed in loyalty to one's school or college is another type of ideal that functions effectively in spurring one on to greater effort. The college or the university that can imbue its students with such loyalty is doing much more to equip them for the battle of life than the institution that simply instructs, no matter how faithfully that instruction may be imparted. It is largely for this reason that the personal influence of teacher and professor counts for far more in the long run than the mere mechanical advantages of libraries and laboratories and work shops.

"It is safe to assert, then, that the main aim in education is to instill ideals that will function as judgments, and that in one

[1] W. C. Bagley, *The Educative Process*, 1905.

sense at least, the subject-matter of instruction must be totally subservient to this aim. . . .

"It is difficult adequately to define in psychological terms just what we mean by the word 'ideal,' yet it is essential that the notion be made as definite and tangible as possible if the dangers of loose thinking, to which educational science is so prone, are to be avoided. The following analysis, although quite independent from the psychological standpoint, may serve this purpose in some measure.

"(1) An ideal is a type of condensed experience. It is the upshot of a multitude of reactions and adjustments, both individual and racial.

"(2) Because it represents condensed experience, it is commonly formulated as a proposition or conceptual judgment. For example—'All men are created free and equal'. . . . Or it may be attached to a single word as 'honor,' 'chastity,' 'truth,' patriotism,' and the like.

"(3) As a condensed experience, it functions in the process of judgment. It serves as a conscious guide to conduct, especially in novel and critical situations. It functions in the initiation of specific habits, and such habits once formed may be said to harmonize with the ideal; but ideals themselves do not function as habit, although the judgments that are based upon them may often be of the 'intuitive' type.

"(4) The development of an ideal is both an emotional and an intellectual process, but *the emotional element is by far the more important.* Ideals that lack the emotional coloring are simply intellectual propositions and have little directive force upon conduct."

An appeal like patriotism can be made very strong, can be made to arouse great emotion, because it is based on many strong instincts, such as the fighting instinct, the maternal instinct (protection of the weak and defenseless), the mating instinct (protection of wife or sweetheart), etc. The ideal expressed by the words, "Blessed are the meek for they shall inherit the earth," is, on the other hand, hard for us all to enter into, for it is on a higher plane than our instinctive behavior and we should have to struggle against ourselves in order to reach it.

The indifferent teacher will consciously introduce the strong, primitive, instinctive elements, and so appeal largely to low

motives. The teacher of power and strength will appeal to a great variety of instinctive elements and, moreover, will constantly keep building those very substantial elements up into more and more highly developed forms. Compare the two following expressions of success.

IT CAN BE DONE

Somebody said that it couldn't be done,
  But he with a chuckle replied,
That "maybe it couldn't," but he would be one
  Who wouldn't say so till he'd tried.
So he buckled right in with the trace of a grin
  On his face. If he worried, he hid it.
He started to sing as he tackled the thing
  That couldn't be done, and he did it.

Somebody scoffed: "Oh, you'll never do that—
  At least, no one ever has done it."
But he took off his coat and took off his hat,
  And the first thing he knew he'd begun it,
With the lift of his chin and a bit of a grin.
  If any doubt arose he forbid it;
He started to sing as he tackled the thing,
  That couldn't be done, and he did it.

There are thousands to tell you it cannot be done.
  There are thousands to prophesy failure;
There are thousands to point out to you, one by one,
  The dangers that wait to assail you,
But just buckle right in with a bit of a grin,
  Then take off your coat and go to it.
Just start in to sing as you tackle the thing
  That cannot be done and you'll do it![1]

SUCCESS

"He has achieved success who has lived well, laughed often and loved much; who has gained the respect of intelligent men and the love of little children; who has filled his niche and accomplished his task—who has left the world better than he found it, whether by an improved poppy, a perfect poem, or a rescued soul; who has never lacked appreciation of earth's

[1] An even better example of this sort of motivation is Elbert Hubbard's famous *Message to Garcia.*

beauty or failed to express it; who has always looked for the best in others and given the best he had; whose life was an inspiration; whose memory a benediction."—Stanley.

The ideals in the poem are based principally on the fighting instinct. It will stir people whom the second quotation will not influence at all. But with the first as a guide one could do almost anything dishonorable and still consider himself a success provided "he got there." And "getting there" might consist merely in gaining control of all the grocery business in a city, by driving every competitor to the wall, or by selling inferior or unclean goods. The little poem has its place, its value. But it motivates life on a low plane. Stanley's definition of success, on the other hand, calls for a much higher type of life.

Ideals are undoubtedly developed by instruction. Much more can be done in this direction than has been done in the past. But certainly a considerable part of all the development of ideals will always be obtained not from one's elders but from one's equals. A mother may comment on the dirt in her son's ears for fifteen years with apparently little effect, but a slight reference to the subject from a girl will probably never be forgotten, judging from the condition of those ears throughout the remainder of life. In the same way dormitory rules or faculty regulations are broken, even on purpose, whenever the student dares. But when the same rules are laid down by the students themselves they are ordinarily lived up to with surprising faithfulness. It is because of these facts that student government in one form or another has grown so prevalent in the last few years. It is realized that moral standards are more quickly and more effectually established when the students are themselves the originators and enforcers of these standards. In many an institution where the honor system is supported by student government—not faculty government with a veneer of student organization—a student would much rather fail than cheat. To cheat would be to debase himself in the eyes of his comrades to such a point that he could never face them again.

In attempting to train students to distinguish between right and wrong, the teacher, besides setting up standards of her own, should endeavor by all means to develop a group-consciousness, to lead the class to work out its own ideals of conduct. In this way the guilty individual will be judged and convicted by his

peers, from whom there is no appeal. The skilful teacher can then gradually, by tactful suggestions, little by little raise the standard as the students grow older, if such needs to be done. Ordinarily children develop their own standards as fast as they are ready to respond to them.

There are some cases where a child's moral standards seem wrong to an adult. For example, all normal adolescent children regard it as unethical to "tell on" a wrong-doer. This is wrong from the adult, civilized point of view. The good citizen must help to enforce the law, must not help to break down the very laws he has himself enacted. But the child cannot see it this way. The true teacher will consider his point of view and will not overrule his standards in this respect. Given a real government of his own to support, the child will, after a time, begin to see that the adult point of view is logically correct and will come to espouse it.

Development of Initiative.—The following extract from Woodworth's discussion of initiative is excellent. Speaking of the task of the manager of an industrial enterprise, he says, "It is his business to get action from people who come into the enterprise as servants. The main difficulty with the master-servant relation is that the servant has so little play for his own self-assertion. The master sets the goal, and the servant has submissively to accept it. This is not his enterprise, and therefore he is likely to show little 'pep' in his work. He can be driven to a certain extent by fear and economic want; but better results, and the best condition generally, can be expected from such management as enlists the individual's own will. He must be made to feel that the enterprise is his, after all. He must feel that he is fairly treated, and that he receives a just share of the proceeds. He must be interested in the purposes of the concern and in the operations on which he is engaged. Best of all, perhaps, some responsibility and initiative must be delegated to him. When the master, not contented with setting the main goal, insists on bossing every detail, continually interfering in the servant's work, the servant has the least possible chance of adopting the job *as his own*. But where the master is able, in the first place, to show the servant the objective need and value of the goal, and to leave the initiative in respect to ways and means to the servant, looking to him for results, the servant often responds by throwing himself

into the enterprise as if it were his own—as indeed, it properly is in such a case.

" 'Initiative'—that high-grade trait that is so much in demand—seems to be partly a matter of imagination and partly of will. It demands inventiveness in seeing what can be done, zest for action, and an independent and masterful spirit.

"The physician who treats 'nervous' or neurotic cases has his problem of getting action from his patients. Strange as it may seem, these cases, while bemoaning their unfortunate condition, cling to it as if it had its compensations, and do not wholeheartedly *will to get well.* They have slumped into the attitude of invalidism, and need re-orientation towards the goal of health and accomplishment. How to bring this about is the great problem. Much depends here on the personality of the physician, and different physicians (as well as mental healers outside the medical profession) employ different technique with more or less of success. The first necessity is to win the patients' confidence; after that, some use persuasion, some suggestion, some psychoanalysis, some (non-medical practitioners) use metaphysical doctrines designed to lead the patient to 'hitch his wagon to a star.' On the intellectual side, these methods agree in giving the patient a new perspective, in which weakness, ill health and maladaptation are seen to be small, insignificant and unnecessary, and health and achievement desirable and according to the nature of things; while on the side of impulse they probably come together in appealing to the masterful and self-assertive tendency, either by putting the subject on his mettle, or by leading him to partake of the determined, masterful attitude of the physician, or by making him feel that he is one with the great forces of the universe. Methods that psychologically are very similar to these are employed by the clergyman in dealing with morally flabby or maladjusted individuals; and the courts are beginning to approach the delinquent from the same angle. All the facts seem to indicate that the way to get action is to have a goal that 'fires the imagination' and enlists the masterful tendencies of human nature."[1]

[1] R. S. Woodworth, *Psychology*, 1921, p. 544ff.

LESSON 44

IN WHAT SEQUENCE SHOULD MATERIAL BE PRESENTED?

The general problem to be discussed in this and the following lesson is: In what sequence should situations be presented so as best to bring about the desired reactions? This involves so many complicating factors that it is impossible to study it experimentally without devoting a good many hours to it alone. Consequently three short experiments have been selected which bear on certain aspects of the problem. The first experiment emphasizes certain factors which determine the difficulty of one assignment as compared with another. The second and third experiments illustrate the varying ways in which different individuals respond to the same stimuli.

All three experiments will be conducted by the instructor as group experiments. Take note of the procedure in each case and of the data recorded on the board. Then work out your interpretations of the results. As an aid to the latter, consider these questions:

1. What factor or factors determine the ease of response to the stimuli in Experiment 1?

2. All of the words in Experiment 2 could have been responded to in the same way by the members of your class. Why was this not the case? What factors affected the response?

3. Which advertisements were the best remembered? Which were the least remembered? Why?

Apply the principles you have deduced here to the problem of determining the order of presentation of material in a lesson or course of study.

LESSON 45

IN WHAT SEQUENCE SHOULD MATERIAL BE PRESENTED?—INTEGRATION

Before attempting to answer the problem in this lesson it is necessary to consider the topic of *Integration*.

It will be recalled that in Lesson 18 learning through reorganization was discussed in terms of: *Associative shifting*, i. e., linking elements together through the use of old established bonds—thus hund and dog were linked together by way of the associations hund-hound and hound-dog; *short-circuiting*, or eliminating steps that were essential in the early stages of learning but not later on; and *integration*. Discussion of this third method of reorganization was reserved for this lesson.

INTEGRATION

Two kinds of integrations will be distinguished: (a) hierarchy of habits and (b) perceptions.

Hierarchy of Habits.—Take the case of learning to typewrite by the touch system. Book[1] reports that in the first lesson writing involved (1) getting the letter to be hit, (2) actually thinking or pronouncing it, (3) mentally locating it on the keyboard, (4) getting the proper finger to the key, and (5) initiating the final letter-making movement. Each of these five steps was gone through in writing each letter, so that in the expression "yours truly" there were involved at least fifty distinct steps. As practice continued, however, these five steps in the writing of one letter on the typewriter were fused into one performance so that when "y" was seen the forefinger of the right hand hit the appropriate key. This fusion took place very largely in terms of short-circuiting. The first two steps fused into one step and the pronouncing of the letter dropped out. The third and fourth fused also. And these two fusions fused together with step five.

[1] W. F. Book, *The Psychology of Skill*, 1908.

Soon the learner ceased to hit one letter at a time as he looked at the letters in the copy, and began hitting several letters one after the other in response to looking at a word as a whole. He had then advanced from the letter stage to the word stage. Finally, in the expert stage, the writer reacts to phrases as a whole instead of single words. So the ten letters in the two words "yours truly" would be hit one after the other very quickly, the writer not fixing his attention at all on any of the separate movements.

Plate XL pictures all this in a rough approximation to the true relations. The learner starts to perform the ten-times-five separate movements. These are coördinated into ten groups, corresponding to letters. Then the letter groups are coördinated into word groups and finally word groups are coördinated into a phrase group. But the expert in writing "yours truly" does not make the original fifty separate movements. He makes far less than that number and he does not make movements exactly like those he originally started with. Due to short-circuiting, the elements are combined into new units, and into much more complex units than were originally present. In other words, at the beginning of practice there was a situation which led to the first response (movement #1 of Y), then a second situation leading to movement #2, etc. In the latter stage the first five situations were transformed into one situation leading to writing "Y;" and in the word stage, the five letter situations were transformed into one situation leading to the response of writing "yours." The unit to which the learner responds becomes more and more complex, and the unit of response becomes more and more complex and different from its original separate parts.

A hierarchy of habits is a grouping and fusing of simple habits into habits of higher and higher orders. As each higher-order habit becomes fully developed it operates as a psychological unit. The lower habits become more and more unconsciously performed. This explains why most experts are unable to describe how they typewrite, use a plane, drive an automobile, or do any complicated act. They have forgotten the stages they passed through in learning and are conscious only of the process as a whole.

A digression for a moment is in order. As the learner proceeds from one stage to the next he must gradually pay less and less attention to the lower habits and more and more attention

to the fusion. If he does not make this change in attention he will not advance in his learning. If on the other hand, he fails to give sufficient attention to the lower habits while in this transi-

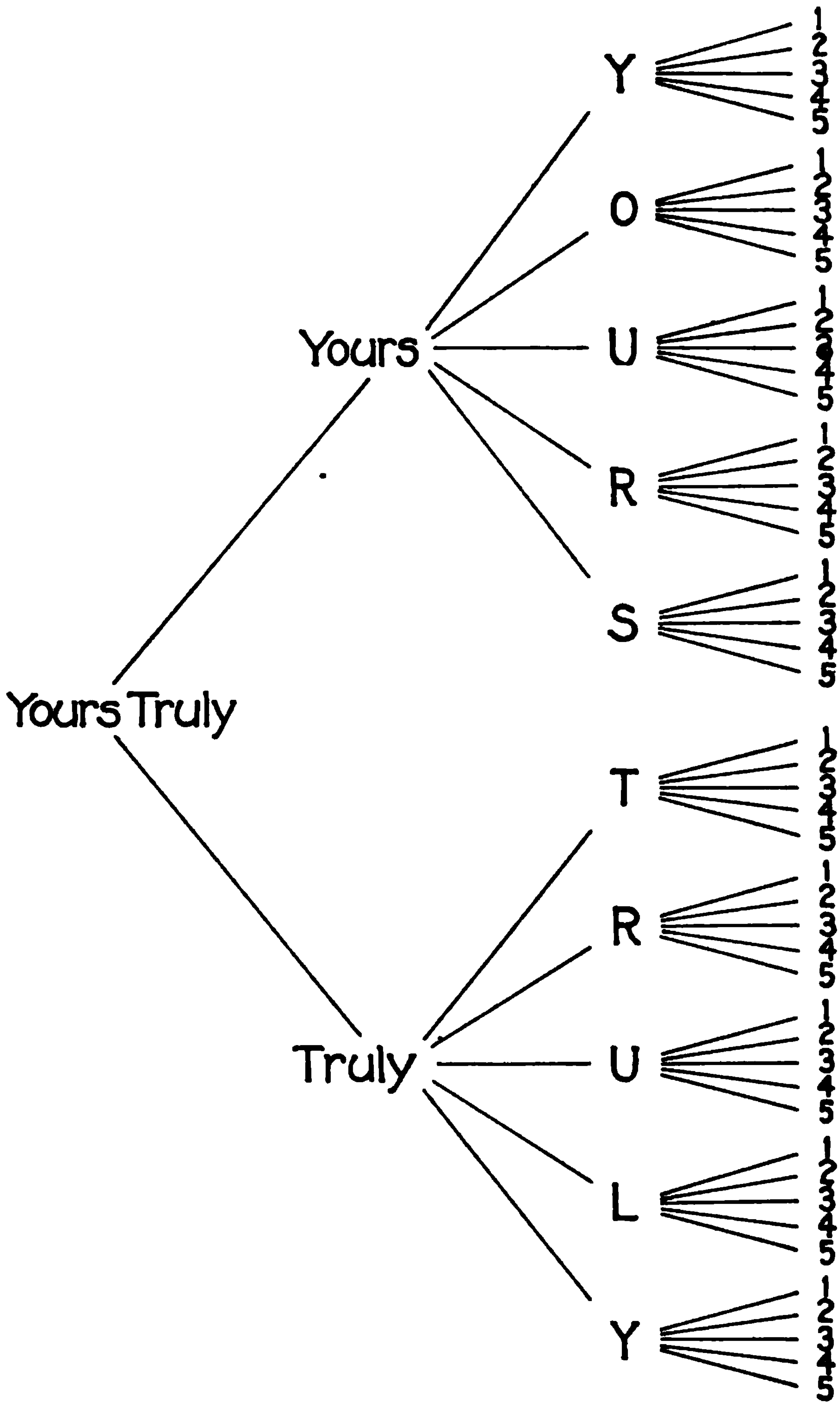


Plate XL.—Diagrammatic Illustration of a Hierarchy of Habits.

tion stage, he will not perform the lower habits correctly. Herein lies the explanation of many so-called careless errors in learning. A very good illustration of such errors appears when students are clearing equations in algebra, and they attempt to do two or

more steps at the same time, instead of doing each one separately. In such a case they should be encouraged to attempt the more complex work, but also be held to account for their slips. Possibly the best procedure is to have them check back each time after having worked the problem in the new way. In other words, they must be encouraged to push ahead, but the new hierarchy will not develop until the lower habits function properly. It is just this condition that causes many of the plateaus in learning. For further increase in speed or accuracy is impossible until the new integrations are well organized.

Study of the psychology of the nervous system suggests that each higher-order habit represents the activity of new nerve cells that take over the control of the nerve cells involved in the lower-order habits. Speaking is a skilled process involving the use of muscles in the throat and mouth. It appears that a certain portion of the cortex of the brain is concerned with control of the movements of the mouth, tongue, and larynx, that another portion of the cortex directly in front controls the skilled movements of speaking a word, that another portion combines the word movements into the still more complex movements of speaking a sentence, and that still another section farther forward combines the movements of speaking sentences so as to secure greater fluency and excellence of speaking.

One of the fundamental laws of human behavior is then that with continued practice separate responses become integrated into more and more highly organized units. This was found to be the case in learning mirror-drawing. At the start any number of random movements appeared. As learning progressed these became fewer and fewer in number, and if the practice had continued long enough they would have disappeared. But some of these movements hit on through random trying were essential to the whole process. These were retained and would have become fused with the old habitual movements incident to holding a pencil, to drawing, to guiding the hand by means of the eye, etc. The same is true of all learning. Swinging Indian clubs or dancing is at first a matter of making separate movements. Later it is simply a matter of making sweeping complex movements.

Perception.—We have seen how movements are controlled through the building-up of more and more complex habits. Let

us turn now and consider how the incoming sensations from our sense-organs are elaborated. These elaborations are called *perceptions*. We speak of the perception of a chair or typewriter when we refer to its appearance. Here consciousness is focused upon the combining of certain incoming sensations and the ignoring of others. All the sensations set up by the chair are grouped and those from floor and walls are not reacted to.

Consider how a percept is developed. For example, a rattle is placed before a baby. The retinas of the eyes are stimulated. As a response the eyes are focused on the object, visual sensations are experienced, and the baby reaches for the rattle. As the fingers close about the rattle the skin is stimulated. Certain new cutaneous[1] and kinaesthetic[2] sensations are experienced. These in turn cause further manipulatory movements causing new cutaneous, kinaesthetic, visual, and auditory sensations. The noise of the rattle is responded to by reflex movements of the baby's head so as to hear better and by consciousness of the auditory sensations.

Thus the baby plays with the rattle for many hours. After a time any one of the stimulations through touch, vision, or hearing will immediately call up any one or all of the responses that have been experienced (due to the principle of stimulus-substitution). In this way the percept of a rattle becomes established. In other words, seeing or hearing or touching a rattle becomes associated with how it appears, sounds, and feels, combined into a unitary consciousness of the whole object.

Possibly better illustrations of perception for adults are these expressions: "I saw the fire engines going up our street last night," or "I saw the square table." Actually I don't do what I say. I didn't see the fire department at all; actually I heard a clanging and whizzing noise growing louder and louder and then dying away. I have at other times actually seen the engines out of the window, but this time I mentally saw them in

[1] Cutaneous stimulations are stimulations affecting the skin, giving one, in terms of consciousness, touch, pain, warmth, and cold, and combinations of these. (Lesson 52 will present the subject in more detail.)

[2] Kineaesthetic stimulations are stimulations affecting sense-organs located in and about the muscles and joints, giving one, in terms of consciousness, movement, weight, pressure, etc.

response to the sounds. Never have I actually seen a square table. I can't get a table in a position so that all the angles appear to be right angles (a photograph will prove this). But because I know the table to have right angles from having handled it, I so interpret my sight of it.

Perception is the fusion of simple sensory impressions. In the case of the rattle, the baby has first of all sensations of vision, touch and sound. The sensations from the same sense-organ fuse into perceptions of the sight, feeling, and sound of the rattle, respectively. A higher-order fusion follows in which all three are fused into a general perception of the rattle. Here again there seems to be good physiological justification for these steps in developing a perception. For certain areas of the cortex of the brain may be destroyed and the perception be destroyed, and we can still see, feel, or hear in the sense of getting sensations, but we cannot put them together so that they mean an object. Every object that we perceive has consequently been built up through combining sensations. Every object that we know has been learned—is a fusion of many experiences.

Images are comparable to remembered perceptions. Thus, I perceive the watch before me, but I have an image (mental picture) of the clock downstairs. Some individuals have very clear images, others have very poor images, or possibly none. There is variation in type of imagery also. Some individuals can mentally see the orchestra of last night but not hear it; others can hear, but not see it. Few individuals have clear images of what has been previously tasted or smelt. Possibly the best time to call up images is just before going to sleep. At that time the writer can frequently obtain visual images which are as vivid as the original object and sometimes as brightly colored, whereas in the daytime he is aware of very few images.

Causes of Some Faulty Reactions

1. Man reacts to the situations confronting him in terms of his situation-bond-response combinations. Consequently detailed situations appear as known objects—unknown objects can be reacted to only in terms of their known parts. Consider the case of a little girl who knows her letters but cannot read. She sees the black marks on the page and recognizes letters. We on the

other hand scarcely see the letters, we see words and phrases, as units, and react to them. In both cases there is a reaction to known objects. In the illustration where the little girl called a pigeon feather "Goose's dress," she reacted to the situation in terms of her experience, which apparently was limited to "goose," meaning all birds, and "dress," meaning all clothing.

This law that "we react to known objects" is so universally true that when a seeming exception does arise, we notice it and remember the occasion for a long time. While the writer was tramping through the Sierras one afternoon, an animal noiselessly slunk across the trail. His reactions were: "It's a fox;" "it's a coyote;" "it's a rabbit;" "it's a beaver;" etc. Later it was identified as in all probability a mink. The reactions even here were reactions to the situation as though it were (1) a fox, (2) a coyote, (3) a rabbit, (4) a beaver, etc. This succession of reactions followed a corresponding series in which different details in the situation were reacted to more prominently than others: "smallness," "slinking gait," "redness," led to fox; "absence of bushy tail" led to coyote, etc. Only after the series of reactions have been made does one put the whole series together and say, "I don't know, it can't be this or that," etc. Such examples are relatively rare in real, everyday life. They are, on the other hand, common in school for there the teacher forces the child through direct questioning to notice a new detail and demands a specific reaction. The question, "what shape are the stamens?" compels the child to notice the stimulus. In everyday life, not having any reaction to the unknown stimulus, we do not make it and hence are oblivious to it. Think of what a geologist sees on a tramp, as distinguished from a botanist, or a zoologist, or a painter, or a day-laborer. An engineer sees in a bridge "compression" and "tension" members. A shoe-dealer always sees your shoes, a milliner your hat, a dentist your teeth, a doctor symptoms of this or that disease. We see what we have learned to see. The same details in the situation are fused into different higher units according to our past training.

In an experiment 137 women were given a copy of *Everybody's Magazine* and required to read an article in it on "Habit." Each had the magazine in her possession one week and then returned it. Then they were tested as to the advertisements they had noticed in the magazine. The upper half of one page

was given over to an advertisement of the Corrugated Bar Company, illustrating material for factory construction; the lower half of the page was occupied with two quarter-page advertisements—the advertisement on the outside of the page was of the Harley-Davidson motorcycle, and the advertisement on the inside of the page was of Mennen's Talcum Powder. 0.0% of the women remembered the Corrugated Bar Company's advertisement, or the Harley-Davidson advertisement, but 7.3% remembered the Mennen's advertisement. Not knowing anything about factory construction or motorcycles they did not react to them and consequently did not see them at all. But they did know about talcum powder and babies and reacted to them, i. e., noticed them. If one shows a group of advertisements to one's friends and then later tests them as to what they have noticed, one will find that they noticed only those advertisements or parts of advertisements that they are interested in. To suppose that they would notice unfamiliar things is to postulate that we can make new reactions spontaneously—a view diametrically opposite to all that we know of human behavior. The details of any situation are perceived and reacted to in terms of learned fusions.

The second experiment in Lesson 44 has illustrated this. The surveyor thinks of "feet" as 12 inches, or as $\frac{1}{66}$ of a chain; the English teacher, as feet in a line of poetry; the average person, as feet to walk with, or shoes, etc. There is no conscious determination to think this way. That particular reaction follows which has most frequently, or in some cases most recently, occurred with that situation.

One of the complaints of business men is that graduates of schools and colleges cannot observe. And they constantly ask that students be taught to observe. The principle discussed here makes it clear that no one can be taught to observe in general. He can only be taught to react to specific situations. Keen observers in one line do not see what experts in other lines view as the simplest and most commonplace details. (Students can be taught as a general principle that when confronted by a new situation they must break it up into its parts. But how they will do this will depend upon their acquaintance with the parts.)

2. A correct perception is dependent upon an adequate number of details being presented. Riding swiftly along a country

road in an automobile one may mistake a stranger for a friend, or may call a mule a horse. In these cases there is not sufficient exposure-time for all of the details in the situation to bring about a reaction; some details are not seen at all. The reaction is, then, faulty because of an insufficiency of the details of the situation. Serious mistakes are not often made because of insufficiency of details, for one nearly always has a feeling of uncertainty, So one is likely to say, "Wasn't that so-and-so?" or if questioned about the mule, say, "Maybe not, but I thought it was."

3. Exceptional situations are frequently reacted to in the manner in which we are accustomed to respond to the more usual situations. For example, if one will cross his first two fingers and then place a pencil between them, it will appear as though there are two pencils touching him instead of one. Ordinarily when the two fingers are touched in these places two objects must be present, consequently now two objects are thought of. (This is called Aristotle's illusion.) After a period of riding in a train, if now one's train is standing still in a station and another train slowly pulls out in the opposite direction it seems as though one's own train is moving ahead. For some time "things flitting by" have meant that one was moving. Now again "things are flitting by" (they really are) and again the same reaction is made to the situation—one declares one is moving. An automobile's speed is generally underestimated as compared with a railway train's. The subway appears to go faster than the elevated in New York City. These estimates are made in terms of the amount of noise; the more noise the greater the speed. But in these particular cases our accustomed habits fail us.

4. Perceptions are frequently made in terms of what has just been experienced. Children are quite likely to multiply instead of add if they are given the problem "4 + 4" after they have been given a number of multiplication problems. Students generally do poorly with a question to which they know the answer, when it is given to them in an unfamiliar setting. The mind is "set" in a certain way, due to the reactions just made, and new situations are reacted to in the same way.

5. Perceptions are frequently made in terms of what is expected. Every year men are shot in Maine by hunters who mistake them for deer. Here the mind is so strongly set for deer

that the least indication of a deer results in the prepared response being made. In the same way a person who is fearful will mistake rocks and trees for highwaymen as he walks along the road in the dusk. In both these cases the person "sees" what he is looking for. James tells us of the time he mistook "North Avenue" for his "Mount Auburn" car.. He was looking for the latter and the former looked enough like it to pass for it. A family will be eating breakfast. A late arrival will taste the milk and pronounce it "sour." Immediately the whole family will agree and refuse to finish their breakfast food. The milk was not sour until they looked to see if it was. The mother may hurry into the kitchen and come back a moment later declaring, "It is not sour, it's right from the cow this morning." Whereon all will proceed with their breakfasts. "It can't be sour, therefore it isn't."

These cases of faulty perceptions, or *illusions* as they are called, all demonstrate the fact that our perceptions are learned and that we react as we are accustomed to react through habits, or as we are expecting to react, or have recently reacted.

6. There are still more abnormal types of behavior where the reaction that is made is even more incorrect. In the case of *hallucinations* the individual reacts as though a certain situation were present when it is not present at all. Delirium tremens patients hear all sorts of noises—the roaring of beasts, ringing of bells, firing of cannons, crying of distressed children. "They are taunted by passing crowds, threatened with death, are cursed, called traitors, thieves, murderers. Paraesthesias of the skin lead to the idea that ants are crawling over them, that bullets have entered the body, and even the absence of wounds does not deter them from exposing their limbs which have been shot full of missiles. Hot irons are being applied to their backs, and dust is thrown in their faces. They can detect the odor of gas, sulphur fumes are being forced through the keyhole." "The content of the hallucinations is not always of a terrifying nature. Sometimes angels are seen; beautiful music is heard. God appears to them, announcing that they are Christs, and empowering them to cast out devils; they are commanded to go to confession and to proclaim the gospel message." In some cases such hallucinations have been traced to internal disturbances, such as a tumor pressing upon a nerve.

There is an intermediate step between illusions and hallucinations called *pseudo-hallucinations*. In this case there is really some external object to which the individual reacts, but the reaction is not typical of normal behavior. For example, the wearer of a tight collar, while dozing, may get the idea that he is being choked by some definite person. Again, the noise of insects on a hot summer night may suggest a word or sentence. The sentence may stand out so clearly in consciousness that the individual is certain that some one has spoken it. Goethe was able to produce such pseudo-hallucinations at will, although in his case he was conscious of the fact that they were imaginary. For example, he could see one flower coming out of another in an endless string. He says, "It is impossible to fix the creation, but it lasts as long as I desire without increasing or decreasing."

Another type of abnormal reaction to external situations is known as *alexia*. Due to injury of the occipital lobe or of the adjacent part of the parietal lobe a person who previously could read can no longer do so. "In such cases the printed characters are seen clearly enough, but have lost their significance. In 'pure' cases, the individual can understand what is spoken, and may even be able to write, though unable to read what he has just written."[1]

Bagley[2] quotes the following: "A merchant lost the ability to put meaning into printed or written words and sentences—the ability to read. At the same time, however, he found no difficulty in recognizing letters that he used arbitrarily as price-marks on his goods. That is, the very same sense contents—letters—were full of meaning to him in one phase of his life (selling goods), but utterly devoid of meaning in another phase (reading). Put in a more general way, this means that the same complex of sensations means different things to the same individual at different times."

These examples of extreme abnormal behavior emphasize the fact that integrations are due to the interaction of groups of nerve cells and that in extreme cases the original situation which gave rise to the fusions may be entirely lacking and that these nerve cells may be aroused in other ways. In such cases the individual reacts as though the original situation were present. He believes

[1] Ladd and Woodworth, *Physiological Psychology*, 1911, p. 252.

[2] W. C. Bagley, *The Educative Process*, 1908, pp. 87–88.

it is present. And, in the case of alexia we have ample evidence that one may react after a brain injury to a situation as one did very early in life, but not as one did just prior to the injury. The injury has destroyed the nerve-cells which were concerned in the elaborate fusions, i. e., in the interpretation of black marks on a page into ideas. These nerve-cells being destroyed, the fusions consequently are lost and the individual reacts to the material as he did before he learned to read, i. e., before the reading fusions were developed.

In What Sequence Should Material be Presented?

A complete answer to this question is, of course, impossible in an introductory course in psychology. But certain principles can be enunciated as growing out of what has been already considered here.

1. Know the Aim of the Curriculum or Course of Study; also the aim or objective of each lesson. What the aim should be is a problem in the philosophy of education. Most instructors have no conscious aim in mind other than the mastery of so much material in a text-book or syllabus. Clearly the aim must be expressed not in subject-matter but in the development of boys and girls.

2. Start with the Wants of the Students.—Preceding lessons have amply demonstrated that without a want or desire little will be learned. As the work proceeds there should be added new wants through suggestion and motivation with the ultimate aim of developing very complex sentiments, such as the self-regarding sentiment. Or, in other words, the student should be led, step by step, to work in terms of more and more remote satisfactions instead of immediate ones.

3. Start with the Knowledge and Skill of the Students.—New habits can only be developed out of instincts and already acquired habits. Unless each lesson builds on what has already been acquired the student will not be able to follow. *Advance from the known to the unknown* is axiomatic. There is no other way of securing attention, of obtaining the desired response. The two Congoleum advertisements in Plate X illustrate this point. In an experiment on 137 women 0.0% noticed the first of these two advertisements. But on the average 5.2% noticed six neighbor-

ing advertisements displaying a fountain pen, a bed, a dessert, ready-built houses, a piano, and a hot-water heater. The writer has been told that this advertisement was a flat failure as far as getting business was concerned. The second advertisement is typical of those run for many years. Evidently it is a success. The writer has no experimental data to furnish here concerning the second advertisement, but by all known principles the first advertisement should have been a failure and the second a success. The former advances from what was unknown in those days (Congoleum) to the known (rugs, etc.) The latter advances from the known (a hallway scene) to the unknown (Congoleum). The word Congoleum being unknown could not be reacted to for there was no bond connecting it with any response. Experiment and experience attest to the fact that it was not reacted to. The second advertisement, on the other hand, can be and is reacted to because a hallway is a situation to which there are hundreds of bonds. Individuals about to build, or those who are making alterations, or who are interested in anything new which will make their homes more attractive, will stop on noticing the cut and see what the proposition is. But they will not stop at the unknown word "Congoleum." From known to unknown is, then, the only way to proceed.

4. Present Situations which the Student will meet in Life and Develop Responses to these Situations.—This point has been discussed at some length in Lesson 17, on how to remember. The two advertisements just referred to furnish us with another good illustration of this point. The primary association which the first advertisement attempts to form is

Congoleum—Substitute for Rugs.

In the case of the second advertisement it is

Substitute for rugs—Congoleum.

The first functions as a sort of definition. If we did pay attention to the advertisement, as we don't, we would learn to know what the commodity is, and when a friend mentioned it, we would say "Oh, yes, I know what that is." But there is no guarantee that we would ever think "Congoleum" when we were considering the advisability of buying a new rug. In the second case the association is formed between the actual situation

of considering a substitute for rugs and the trade-name "Congoleum." Hence when we are later contemplating buying a new rug, "Congoleum" comes to mind, because a bond has actually been formed (through reading the advertisement) between (a) the actual situation in life which will arise and must needs precede the buying of a rug, and (b) the trade-name.

5. Build up Complex Integrations.—The student who gets an "education" by taking a great variety of short courses develops many habits, but they are nearly all lower-order habits. On the other hand the student who continues a subject for years must build up habits of higher and higher order. In this way he obtains broad, general conceptions of the subject that the mere dabbler in that field can never reach. One ideal in education should be to develop such general conceptions, for then the student is equipped to react in terms of a vast number of experiences and so is much more likely to make truly appropriate adjustments to his environment.

Though the development of such general conceptions or principles is most desirable, it must be borne in mind that men differ greatly in general intelligence. This means that the less their intelligence the more difficult it is for them to build up higher-order habits. Too many advocates of culture as the aim of education overlook this fact. They fail to realize that not everybody can learn as they have. Experts in vocational education, on the other hand, have learned this fact from experience and have introduced many short courses and have employed the project-method quite extensively, because these methods are better adapted to training men for a job than the usual methods employed in high-schools and colleges. But in some cases vocational training has been organized on too simple a basis so that there has been little opportunity for the development of any higher-order habits. One business executive summed up the whole problem very well when he said that his foremen were concrete-minded and that all training for foremen as foremen must be specific training whereby they would be taught just what to do when confronted by any situation on their job. But he went on to add that training of his foremen for higher positions must be in terms of more general principles, else they would not qualify for promotion. Apparently the ideal instruction would be concrete, with opportunity for those who could to

organize the concrete elements into more and more general principles. Applied to public-school procedure this means that dull children must be taught as many responses to the situations that they will meet as possible, while bright children will be taught all of these and very much more, with a great deal of emphasis upon general principles. Today bright children are not given enough to do, nor is the work difficult enough to challenge their powers, and dull children are given too much to do and much of it is too abstract for them ever to grasp it—and if they could, they would practically never use it.

LESSON 46

WHAT ARE SOME OF THE ESSENTIALS OF GOOD DRILL WORK?

Is drill work necessary? Must we go over our lessons again and again? Does practice make perfect? Should drill be the basis of all learning? If so, how should it be conducted? If not, are some things to be learned through drill and others to be learned in another way? How shall we distinguish between the two types? These and many other questions confront the educator of today. Let us consider some of these problems.

Introduction

All learning is the formation of new bonds or the reorganization of old ones. In Lesson 11 "rote memory" was distinguished from "associative thinking." If we learned that "hund" meant "dog" through sheer repetition we assigned the case to the former type of learning; if we learned that "hund" meant "dog" through the intermediary step of "hound," we assigned it to the latter type. Practically there are few examples of learning that can be considered really typical of the one type and not of the other. Most cases of learning partake of both—we form new bonds and we reorganize old bonds. For convenience, however, we can assign some tasks to the first group, such as learning the addition or multiplication combinations, learning many words in a vocabulary, many chemical formulae, many dates in history, etc. And to the second group can be assigned such tasks as learning through performing the experiments in this lesson, studying the next lesson, learning how a building is constructed through watching its construction, etc. As already stated, however, most cases involve both types. In fact it is very doubtful whether the average person employs only rote memory even in learning the multiplication tables, and again whether he can get along without any rote memory at all in studying the next lesson.

A few years ago the emphasis was upon memorization, and even now in some schools students are taught no other way to study then to commit the text to memory. But in many educational institutions today the pendulum has swung over to the

other extreme and all the emphasis is upon reasoning or associative thinking and none upon rote memory. It is certain that emphasis upon associative thinking rather than rote memory is to be preferred; but to ignore the latter completely is not wise. A teacher holding a responsible position in a large city school system said the other day, "It would be as much as my position is worth to have the superintendent discover me drilling my children!" Such a condition of affairs is all wrong. It implies a very inadequate notion of the psychology of learning. The only effectual way to learn some things is to sit down and go over the material again and again until it is mastered.

The Experiments for Today

Three short experiments will be performed today. Do them in the order indicated and finish all three before referring to the questions that follow. A knowledge of the questions only upsets you so that you do not do the work in your natural manner, and as we want to discover the facts of learning we must needs guard against abnormal interfering factors.

Problem.—What are some of the essentials of good drill work?

Apparatus.—Watch with second hand.

Procedure: *Part* 1.—Imagine yourself back in the fourth grade in a class in handwriting. Copy fifteen times the line "Learning is the development of new habits."

Both partners should do this part.

Part 2.—Have S call out 15 times, "Start" and then "Stop" with an interval of what he judges to be 15 seconds in between. S should not practice this at all, not even once, before starting. E is to record the actual number of seconds that elapsed each time between S's two signals, but must not indicate by word of mouth or by facial expression any comment on S's performance.

Now repeat the performance, but this time E will report to S each time what the actual length of time was which he judged to be 15 seconds. Record his estimates as before.

Part 3.—One partner will now commit to memory the multiplication table for 17 according to Scheme A, and the table for 19 according to Scheme B. The other partners will commit to memory the multiplication table for 17 according to Scheme B and the table for 19 according to Scheme A.

Scheme A.—Recite the table over and over as given below

until you can shut your eyes and recite it correctly. Do not practice any more than is just necessary to give you the ability to recite the table correctly. Record your learning time.

1 × 17	17	1 × 19	19
2 × 17	34	2 × 19	38
3 × 17	51	3 × 19	57
4 × 17	68	4 × 19	76
5 × 17	85	5 × 19	95
6 × 17	102	6 × 19	114
7 × 17	119	7 × 19	133
8 × 17	136	8 × 19	152
9 × 17	153	9 × 19	171
10 × 17	170	10 × 19	190
11 × 17	187	11 × 19	209
12 × 17	204	12 × 19	228

Scheme B.—Recite over and over in rotation the first three of the four different arrangements of the 17 or 19 table, as the case may be, until you can cover up the answer column and answer the combinations correctly. Record your learning time. (But do not practise the fourth arrangement at all.)

7 × 17	119	4 × 17	68	9 × 17	153	12 × 17	204
4 × 17	68	7 × 17	119	6 × 17	102	2 × 17	34
11 × 17	187	12 × 17	204	4 × 17	68	6 × 17	102
8 × 17	136	9 × 17	153	12 × 17	204	9 × 17	153
5 × 17	85	10 × 17	170	8 × 17	136	1 × 17	17
2 × 17	34	2 × 17	34	1 × 17	17	5 × 17	85
9 × 17	153	1 × 17	17	3 × 17	51	3 × 17	51
6 × 17	102	8 × 17	136	11 × 17	187	10 × 17	170
3 × 17	51	3 × 17	51	7 × 17	119	8 × 17	136
10 × 17	170	6 × 17	102	5 × 17	85	11 × 17	187
12 × 17	204	5 × 17	85	10 × 17	170	4 × 17	68
1 × 17	17	11 × 17	187	2 × 17	34	7 × 17	119

7 × 19	133	4 × 19	76	9 × 19	171	12 × 19	228
4 × 19	76	7 × 19	133	6 × 19	114	2 × 19	38
11 × 19	209	12 × 19	228	4 × 19	76	6 × 19	114
8 × 19	152	9 × 19	171	12 × 19	228	9 × 19	171
5 × 19	95	10 × 19	190	8 × 19	152	1 × 19	19
2 × 19	38	2 × 19	38	1 × 19	19	5 × 19	95
9 × 19	171	1 × 19	19	3 × 19	57	3 × 19	57
6 × 19	114	8 × 19	152	11 × 19	209	10 × 19	190
3 × 19	57	3 × 19	57	7 × 19	133	8 × 19	152
10 × 19	190	6 × 19	114	5 × 19	95	11 × 19	209
12 × 19	228	5 × 19	95	10 × 19	190	4 × 19	76
1 × 19	19	11 × 19	209	2 × 19	38	7 × 19	133

When both partners are through let each test the other as to his ability to read down the fourth of the four arrangements of the 17 and 19 tables as given under Scheme B above. S should cover up the answer column and not refer to the answers until entirely through both tables. E should record the time consumed by S in giving the answers to each table and any mistakes.

Results. *Part* 1.—Incorporate the 15 copies of your handwriting in your write-up. Record estimates by yourself and partner as to how much better or poorer the last three copies are than the first copy.

Part 2.—Plot two curves showing the data obtained from S in the two practices.

Part 3.—If S made any mistakes in reciting to E the multiplication combinations at the end of the experiment, add $1/5$ of the total time to his time record for each such error. Record in a table the time consumed by each partner in learning according to Scheme A and Scheme B. Also record their average time. (If these records do not look right to you, obtain the records of other pairs of partners and give a final average in this way for four, six, or eight individuals.)

Conclusions.—(1) Evaluate the two maxims, "Practice makes perfect" and "If at first you don't succeed, try, try, again."

2. In Lesson 11 mention was made of the fact that in learning one is very likely to associate items in a list with their position in the list. Is this an advantage or disadvantage? Explain.

3. What other conclusions can you deduce from these experiments as related to drill work? Explain.

Applications.—(Write up your report and hand it in at the next class hour.)

LESSON 47

WHAT ARE SOME OF THE ESSENTIALS OF GOOD DRILL WORK? (continued)

Drill work presupposes, of course, learning through repetition. What else is involved? Consider this illustration. Suppose the person who can count but does not know the multiplication tables, is frequently called upon to get the total of six items taken seven times. The steps in learning that six sevens are forty-two would be: (1) Six marks or matches or fingers would be counted seven times. To be sure of the answer the counting would have to be done at least twice. After a number of experiences the next step would be attempted, i. e., (2) counting by groups, i. e., by sixes, (the marks or matches being used now only *mentally*). Still later, (3) the number forty-two would occur before the counting was finished. Usually the counting would be gone through with just the same because of lack of confidence in this premonition. (4) The number forty-two would sometimes pop up before the counting started. (5) The number forty-two would occur every time as soon as the situation was encountered. (6) The time interval between comprehending the situation and the occurrence of the response of forty-two would become less and less.

Here we have many repetitions. The process, however, of getting the answer has steadily changed—it has been short-circuited into fewer and fewer steps until only one step remains. Which part of the whole process of learning is drill? In one sense the whole process has been drill; but the term is more commonly restricted to step (6) where the essential change is no longer in procedure but only in reaction time. All educators would insist on teaching a subject until the answer can be given without resort to obviously round-about methods, but many today refuse to go further and cut down the time of the performance, on the ground that this would be mere memorization, which to their

thinking has no place in school work. A group of college professors recently agreed that there was nothing in their courses to be memorized; reasoning alone was appealed to!

Obviously, it depends upon circumstances whether a student should be permitted to stop at step (1) or go through to step (5), or to submit to days of drill in step (6). What performances should be drilled?

What Performances Should be Developed through Drill?

At least four general answers can be given to this question. They overlap, however, more or less.

1. All Habits Which Function Frequently in Daily Life as "Tools" Should be Drilled Upon.—Arithmetical combinations up to 10 × 10 are regarded as combinations which are met so frequently in life that they need to be learned in order that daily complex situations may be reacted to promptly and correctly. These combinations must be learned in one specific manner, because that way is the shortest and most efficient.

It is a mistake to allow children to learn their arithmetical combinations by so-called short-cuts, as, for example, when confronted with "9 + 7" to think "10 + 7 is 17; 17 − 1 is 16." It is true they can often reach the answer more quickly than do children who learn "16" outright as the answer to "9 + 7," but throughout life they will in all probability require about twice as much time to get the answer as the second group will.

The same is true, to a great extent, of spelling; only through repetition can the correct spelling of many English words be learned. An intermediate step (phonics) can be used to advantage for a time. Through this drill the child comes to learn new words through the reorganization of old bonds instead of slowly forming entirely new bonds for each new word through repetition.

Through the use of the moving-picture machine followed by a careful study of the pictures, it has been discovered that all persons, even experts, make many inefficient movements while performing their work, whether this be typewriting, tending a machine, or laying brick. In many places employees have been trained to perform their task in the one best way. This has in many cases increased the production very greatly and with

proper safeguards has not increased fatigue—in some cases it has actually decreased fatigue. At one conference of men interested in industrial education considerable attention was given to this phase of learning as it applies to draughting and the handling of tools. The point was made that the first step in scientific teaching is to determine, for example, just how to use a draughting pen, and the second step is to drill the student in that performance until he can do it accurately and rapidly. Observation of professional draughtsmen had revealed many different ways of using the pen; some of them were efficient and some quite inefficient. Such men learned the process by themselves, picking up a good deal of their knowledge and skill from observing others. Psychologically stated, they learned very largely through utilizing already formed bonds. The ideal upheld at the conference was to force the beginner to use his tools correctly and to drill him at doing so until he used them easily and efficiently.

Not only must these habits which act as tools be learned through drill but *they must be drilled and drilled upon until they act automatically*, i. e., act like reflexes. The writer's estimate as to why children fail in arithmetic above the third grade is that it is due approximately one-third to inability to do automatically the simple fundamental processes already supposed to be learned, and one-third to inability to understand the English of the problems. We are concerned here only with the first factor. Take the sample, "Fred buys 6 apples at 3 cents each and gives the groceryman a quarter. How much change should he get back?" Here the child must (1) multiply 6×3, and (2) subtract 18 from 25. But all the time he must keep the problem in mind. If the two arithmetical processes can be performed automatically as soon as it is appreciated that they must be performed, then the child can keep the problem before him and so perform each step properly and in its right sequence. But if he must devote all his energies to finding what is 6×3 then the problem will slip out of his mind and the chances are that he will either have to reread the problem or will get a wrong answer. To know that 6×3 equals 18 is not enough. It must be so known that the answer will come immediately even with the mind almost entirely occupied with grasping the meaning of the problem.

In a final examination in Freshman mathematics the first hundred papers read all contained solutions to the problem:

$$\text{Find value of } \frac{(\sin 2280^\circ)(\tan - 1845^\circ)}{(\csc - 30^\circ)(\cos - 300^\circ)}$$

As all of the hundred students chose to answer this problem (having an option of several) it is evident that they viewed it as one of the easiest in the examination. Yet 50% of them failed to solve it. An analysis of their work shows that 41% had everything right except one step and that 49% of all mistakes were made in this one step. The one step was substituting the values of cos 30°, tan 45°, etc. If they did not know these substitutions they could have looked them up in their tables which they had with them in the examination room. They thought they knew them (and they should have), but didn't. Their instructors pride themselves that no memory work is required! Clearly the students should be taught always to look up such values (comparable to looking up 6 × 7 in arithmetic), or else to drill themselves until they really know them.

"Tool" habits must not be viewed as very simple habits. They may be very complex. The proper organization of material in writing up a laboratory notebook, or using statistics, or taking notes according to an outline, or organizing material properly, are good examples of complex "tools." Because they are useful in making one think clearly, they need to be drilled upon until the mechanics of such thinking are no longer troublesome to the student and practically all of his energies can be devoted to solving the problem with the use of the tools. It is pathetic to see so many college Freshmen today who cannot outline at all, or can do so only with such great difficulty that it is not worth while.

Habits, then, which function frequently in life as "tools" need to be learned through drill work and to be reduced to an automatic basis.

2. Skill Can be Obtained Only through Drill.—In the preceding section habits were to be drilled upon because they served as "tools" in the reacting to thousands of different situations met in life. In this section habits are to be drilled because they must be used for their own sake very largely. Examples are

high jumping, swimming, typewriting, playing a violin, sewing, and the like. Facility in such performances is spoken of as *skill*. Skillful manipulation of a violin means that many finger-movements have been developed through trial-and-error and have been practiced thousands of times until the learner has approximately reached his physiological limit in producing them.

Judd[1] gives two instances of how skill is dependent upon the mastery of certain processes through trial and error. In learning to write with the pen, "we are guided," he says, "in the formation of letters in large measure by the sensations of pressure which come to us through the fingers which hold the pen. Especially is this true with regard to the height of letters. Let anyone try to make his letters twice as high as usual and he will at once become aware of the fact that the relations of pencil and paper are such that the pencil at the top of the letter tends to leave the paper. The old-fashioned shading of letters showed the same fact in another way. No heavy shading was made by upward strokes. The downward strokes were the heavy strokes, because here the pen came with increasing pressure into contact with the paper. The changes in pressure which control the height of our letters are not ordinarily recognized by the writer. Little children are more dependent than are adults on intense experiences of pressure. They break the points of pen and pencil because they press too hard in trying to secure intense sensations. The pressure sensations (kinaesthetic sensations) help them and help the adult in guiding movements. We speak of these sensations, therefore, as controls of writing, because as soon as the pressure at the top of a letter gets light the skilful writer is controlled in his movement and turns back. In like manner he is controlled at the bottom of his letter by the increasing pressure.

"Every habitual act is governed by certain sensory controls. Each tool in the manual-training shop has its particular system of controls. Take, for example, the saw. When one drives the saw forward, it should engage the wood vigorously, just as the pen makes naturally a heavy downward stroke. When the saw is drawn back it should pass lightly over the wood. The skilful sawyer makes his movements without stopping to analyze

[1] C. H. Judd, *Psychology of High School Subjects*, 1915, pp. 254–255, 261–262.

the experience. The learner, on the other hand, has to pay close attention in order to acquire the proper adjustment of movements and sensations. Furthermore, the expert sawyer is instantly responsive to the sensations which come from his saw if the line which he is following is not perfectly straight. Let the saw swerve ever so little and the skilful workman makes the necessary turn of his hand. He knows, further, how to adjust his stroke to different kinds of material; and he knows also that when the board is just about divided he must make a skilful stroke in completing the cut which the novice does not know how to accomplish."

Our present educational system aims to develop skill in but a very few cases. Shorthand and typewriting are drilled upon in some schools to such an extent that one may fairly speak of the student's accomplishment as skilful. In the ordinary course in manual training or domestic science, the boy makes a table but once and goes on to another assignment, and the girl makes a salad once and takes up another recipe the next day. All that is aimed at here is general knowledge together with the development of skill in handling a few instruments, such as the hammer and saw, the egg-beater and rolling pin. If the student ever does acquire real facility in cabinet work or in cooking, he or she acquires it outside the school, not inside. For skilfulness can come only through repetition of the same process over and over again.

The same thing applies to German and French and to most of our courses in school and college. Practically no one can speak or read or write German with any real degree of fluency as a consequence of school training. The case is no better for Latin, which is generally studied for a longer period of time, if studied at all. Probably only in the two subjects of English and mathematics do we find students approximating a real stage of skilful performance. Mathematics lends itself particularly to drill work, and yet many a college student cannot add a column of 15 figures with any degree of facility. And any one familiar with the papers handed in by college students, particularly in non-English courses, would hesitate to say that eight years of English in grammar school, four in High School, and two in college insure skilful use of the English language.

The American people have not yet determined just what they

want the public school to accomplish. Until they do, the psychologist cannot lay down a program as to how to teach the different subjects. Apparently the acquisition of skill in anything but English and simple arithmetic is not really desired or there would be a more earnest attempt on the part of educators to secure it. It should be born in mind, in this connection, moreover, that if skilfulness is to be desired, it can be obtained only as the result of long training during which both pupil and instructor will need to exercise the highest qualities in their character to keep them at the task. The expert never reaches his goal by "playing at" his task.

3. Certain Performances Prized for Their Aesthetic (Pleasure-giving) Qualities Can be Mastered Only through Drill.—The memorization of the Twenty-third Psalm will illustrate this type. Through careful reading the thought of the psalm may be gained first. This leads to the organization of much of the material in terms of old habits of thought. But after all that can be accomplished in this way has been done, the learner must settle down and get the rest through repetition. For the enjoyment of reciting the psalm just as it is written is desired. Here drill work is necessary. Memorizing poems, jokes, selections on the piano, sleight-of-hand tricks, Indian-club exercises, etc., can be thought of as belonging in this group, although psychologically these performances could be included under the other two headings.

4. Clean-cut Accurate Thinking is Dependent in Some Cases upon Drill.—Physics, for example, is a subject which develops step by step through the precise use of what has gone before. Every term has a definite meaning. Students who learn to employ these terms in their exact scientific meaning are saved many an error that other students fall into. Today efficiency is lowered far more than we realize because students are encouraged always to think everything out instead of utilizing at least some of the knowledge of experts. This is not a plea for memorization without understanding—the failure of much teaching in the past; but a plea for memorization of definitions, principles, and laws after complete mastery of their meaning.

So much for the question as to what performances need be learned through drill work. Let us now turn our attention to the question as to what should be the guiding principles underlying drill work.

What Guiding Principles Should Underlie Drill?

1. "Put Together What Should Go Together and Keep Apart What Should Not Go Together."[1]—We have seen in Lesson 11 that if

$$S_1 \longrightarrow R_1 \text{ and}$$
$$S_2 \longrightarrow R_2$$

occur together several times, bonds may be formed between S_1 and R_2 and between S_2 and R_1. If this fact is kept in mind this rule becomes a very vital one in teaching. If we are endeavoring to develop $S_1 \rightarrow R_1$ and $S_2 \rightarrow R_2$ and not the bonds $S_1 \rightarrow R_2$ and $S_2 \rightarrow R_1$ then the two $(S_1 \rightarrow R_1)$ and $(S_2 \rightarrow R_2)$ must not be repeated together, but must be kept separate.

In teaching the spelling of new words, this means that the correct combination of letters should be presented, and never the wrong combination. In teaching reading, it means that the names of the letters should not be given but only the sounds of the letters. To teach "b" as "bee" instead of "bu" is only to confuse the beginner when he attempts to pronounce "bug." In handling children at home, this principle means that we must never frighten children with the bogy man or about the dark. We want a child to grow up with no thought of the dark as a terrifying thing. Hence, keep all such notions away from him.

2. Have a Definite Standard before the Student as to What is the Goal.—In the second experiment in Lesson 46 the necessity of this principle was most strikingly demonstrated. In the first part of that experiment S had no standard to check himself by. In the second part of the experiment he had one, and as a result could and did make great progress. The first experiment also illustrates this same fact. The copying tended to get worse rather than better, because there was no object stated for the writing nor any model present to be imitated. Herein lies one of the chief merits of educational norms.

3. "Reward Desirable Connections and Make Undesirable Connections Produce Discomfort."—If E had frequently praised or condemned the work in either of the experiments just mentioned, better work would have resulted. The maxim "Practice makes perfect" is true, provided the learner keeps continually checking up his production by a standard, or is praised for good

[1] E. L. Thorndike, *Educational Psychology*, 1913, Vol. II, p. 20.

work and condemned for poor work. But practice with neither of these elements present is as likely to lead to poorer work as to better work. Many a woman brings up her fifth child just as badly as she did her first; many a teacher teaches no better at fifty than at twenty-five. (Review here what is presented in Lesson 15 on the Law of Effect as it relates to the strengthening of a bond; also the effect of approval and disapproval in Lesson 34.)

4. Drill in Such a Way That the Learner Will Make the Proper Response to Situations Which He Will Actually Meet in Life.— This principle has already been discussed in Lessons 17 and 45. Three further illustrations add to the subject, however. Children need to know arithmetical combinations. There is no reason why the answers should not be taught as direct responses to simple combinations, e. g., situation, $\frac{4}{\underline{3}}$; response, 7; and not as taught in so many schools, e. g., situation $\frac{4}{\underline{3}}$; response, 4 and 3 are 7.

If the purpose in high school physics is to teach boys and girls to be able to repair electrical apparatus about the home, then situations similar to those met in the home must be presented in addition to mere problems from the book. (See discussion in Lesson 17.) Again, if the purpose of teaching geometry is to train students to think, as is so often claimed, then methods must be changed. For example, the method of arguing by "*reductio ad absurdum*" is nowadays developed in geometry. The situations to which it is tied are all geometrical problems or theorems. When these are presented the method may appear. When the term itself is presented students can discuss its meaning, use, and value. But students scarcely ever use it anywhere else in their work in school or in life. Recently the writer asked a class of 17 advanced students how many understood the term. All did. "How many have ever used that method of argument?" Only one, and he stated that his father used it frequently and that he had learned it from him, not from his geometry. Of what use is their knowledge of this method, if it is never employed? Practically none. What is needed is to present a large variety of situations from real life and connect them up with the reactions of using the method.

(Some readers may protest at this, and may maintain that the business of the geometry teacher is to teach geometry, and that the place to learn to use the "*reductio ad absurdum*" method of argument is a class in argumentation. Consider such a point of view in the light of what a prominent mathematics professor has said, namely, that all the mathematics in the High School course in geometry could be easily taught in one month; the remainder of the material in the course is supposed to be there for the purpose of training students to reason. All that is accomplished along this latter line in most geometry courses is to "reason" out geometry problems. But what is needed in this subject, as in all school subjects, is not the teaching of the subject-matter but the development of boys and girls. The content can be taught, but it is a means to an end, not an end in itself.)

5. Guard against Interference Effects as Much as Possible.—In Lesson 15 we saw that one repetition of "D 84" resulted in 4% of the S's recalling 84 when D was again encountered. But when R was shown with 18 and again with 42 and later R was presented alone, neither 18 nor 42 could be recalled. We said that R-18 interfered with R-42 and vice versa, so that recall was impossible. This matter of interference should constantly be considered in all drill work. Pupils should be so handled that they will make a minimum of mistakes. An unintentionally mispelled word on the board may necessitate three or four times as much drill upon that word as would be necessary if the pupils had not seen it written out incorrectly.

In teaching short division, it was formerly customary to have the process written out as follows:

$$\begin{array}{r} 9\overline{)5076} \\ 564 \end{array}$$

Then when long division was taken up the process was changed to this:

$$\begin{array}{r} \underline{94})5076(\underline{54} \\ \underline{470} \\ 376 \\ \underline{376} \end{array}$$

But setting down the answer on the right instead of underneath caused endless confusion (interference). Today it is recognized

that the best scheme is to arrange long-division problems in the same way as short, i. e.,

$$\begin{array}{r} 564 \\ 9\overline{)5076} \end{array} \quad \text{and} \quad \begin{array}{r} 54 \\ 94\overline{)5076} \\ \underline{470} \\ 376 \\ \underline{376} \end{array}$$

No one has ever experimentally determined whether it is better to teach addition and multiplication combinations at the same time or one after the other, whether to commence German and French at the same time or one after the other. There are some theoretical advantages to be urged for both plans. We need expert advice here. But in all probability it will be found that better results can be obtained by reducing the addition combinations to something like an automatic basis before introducing the interfering multiplication combinations, for the two situations that look alike $\begin{array}{c}6\\ \underline{4}\end{array}$ lead to two different responses, i. e., "10" and "24." Drill on the addition and multiplication combinations separately eliminates interference to a large extent. Then later they may be presented at the same time to develop a realization that there is another element in the situation besides just the $\begin{array}{c}6\\ \underline{4}\end{array}$, i. e., the idea of "addition" or "multiplication."

6. Do Not Permit Drill Work to Become Monotonous.—It is in the child that the ill effects of monotony are to be guarded against rather than in the teacher. Of course, if the teacher is bored he will not do so well as when interested; but a good teacher can make himself interested if he sees progress resulting from his efforts. The distinction between monotony to the child and to the teacher is drawn here because many a time the child enjoys what is boring to the adult. Small children enjoy repetition for its own sake—their games are largely composed of repetition of simple processes continued almost without end. Three girls, aged seven to nine, spent a good share of one summer bouncing a golf ball and counting in unison up to three hundred, the limit of their game.

But there are limits to the interestingness of repetition with children. And when these limits are approached the teacher

should drop the procedure immediately and start another. So in a lesson in which the distinctions between "noun" and "verb" are being established, examples can be given and then called for after the preliminary presentation of the subject. Then sentences can be asked for made up of given nouns, of given verbs, and of given nouns and verbs. Drill on the characteristics of each may follow and then the need for the distinctions may follow, etc.; the greater the variety of activities the more interesting to all. But throughout the whole lesson the one idea should run clearly and emphatically—"nouns vs. verbs." In this text the conceptions of "situation-bond-response" and "characteristics of learning curves" have been drilled, for example, very much more than is customary. But the aim has been to present them in a great variety of ways so as to secure interest because of novelty and to avoid the feeling of monotony.

Which Should be Emphasized in Drill Work—Speed or Accuracy?

In the mirror-drawing experiment (Lesson 7) it was quite clear that if S had in mind "speed" his time curve would drop rapidly and his accuracy curve would drop more slowly, or might not drop at all; and if S had in mind "accuracy" the reverse would be the case. Apparently, the answer to our question as shown by this experiment is that both must be emphasized. If either alone is emphasized, the other fails of development. A study of hundreds of learning curves in this and other experiments, however, leads the writer to the conclusion that emphasis upon speed seldom results in neglecting accuracy entirely, whereas emphasis upon accuracy may often result in ignoring speed. If an instructor should talk speed all the time he would also secure considerable improvement in accuracy, but emphasis upon accuracy may bring little or no improvement in speed.

Thorndike[1] reports the following table on the relation of speed and accuracy. Six hundred and seventy-one college students were divided into eight groups on the basis of the rate at which they could do simple addition. The second column gives the number of additions made in 100 seconds, and the third column the number of mistakes. After practice the rate was increased

[1] E. L. Thorndike, On the Relation between Speed and Accuracy in Addition. *Jour. of Educ. Psychol.*, Nov., 1914.

and errors reduced, as shown in the fourth and fifth columns respectively. Basing our results on group averages, as in the table, it is clear that the more rapid the workers are the more accurate they are. If the individual records were examined individual exceptions would be found. But they are far fewer in number and importance than the records of those who conform to the rule. At the close of practice the fastest workers did 162 problems in 100 seconds as against 46 problems for the slowest workers, and the fast ones made but 3.8 mistakes in 1000 as against 14.4 mistakes in 1000 by the slowest workers.[1]

No. of individuals in the group	Before practice		After practice	
	No. of prob. done in 100 seconds	No. of errors per 1000	No. of prob. done in 100 seconds	No. of errors per 1000
65	150	7.0	162	3.8
108	108	9.1	120	6.5
86	88	10.3	99	6.7
115	75	12.0	87	8.3
109	64	12.7	75	9.0
103	55	12.6	66	9.3
65	46	14.4	58	10.5
20	37	17.5	46	14.4

In 1912 R. S. Selvidge tried this experiment in teaching draughting. In the first section he handled the students as is customary, emphasizing both accuracy and speed. (The truth of the matter is, however, that accuracy is actually uppermost in the minds of students in such a course.) In the second section, they were trained in planning out just what they were to do before picking up their ruling-pens or triangles. They were called upon to submit a plan with the details numbered in the order in which they were to be executed. When this plan was approved, they were allowed to proceed. They were timed with a stop-watch while actually working, and the time was recorded on the drawing. At the end of the fourth week the second section had done more work than the first section but of not quite so good quality. At the end of the sixth week the

[1] Striking results from drill in silent reading are reported by J. Q. O'Brien, *Silent Reading*, 1921.

execution was equal in both sections, while the second section had finished several more drawings. At the end of the semester, the second section had done twice as much work and the execution was better.

In such work as draughting accuracy is emphasized by the very nature of the task. A drawing must look neat and must come out correctly, else both student and instructor are displeased with it. In Selvidge's first section, then, speed was only mildly emphasized as contrasted with accuracy. In the second section the two factors were probably equally important in the minds of the students, or (if anything) speed was the more prominent. The result was that all of the unimportant movements, such as reaching for a ruler, pen, or triangle, or filling the pen with ink, etc., were made quickly, whereas in the first section much time was lost through dilatory movements. Moreover, even the important movements in drawing lines were made more quickly in the second section.

To do an act slowly is a different psychological process from doing it quickly. Try combing your hair or tying your necktie in half the time, or in twice the time, and notice how changing the rate upsets the whole process. It is a false notion that we can learn to do a thing slowly and afterwards readily increase the rate of doing it. The easiest way is to learn right from the start to execute the act as rapidly as we can. In a short time we shall reach for our pen, shave, put on our clothes, or run a machine, at top speed instead of slowly. And within very wide limits fatigue will result no more rapidly from the rapid work than from the slower.

Out in life the world expects to have the job done correctly and within a certain time. It is as much a failure to be slow as to do the work poorly. The present extreme emphasis in our educational world upon accuracy is not preparing our boys and girls to cope with business conditions. To allow students to turn in their themes a week or a month late is to encourage habits which are inimical to their best interests.

There is still another angle to this question of speed vs. accuracy. College mathematicians and English teachers are not free from simple errors in adding or spelling. But they know their limitations and are constantly checking their work or using a dictionary, as the case may be. The goal in teaching such

subjects should be as great speed as is consistent with perfect, or nearly perfect, accuracy. And this accuracy is to be based on habits of checking which through drill have been made practically automatic.

PROPER CONCEPTION OF DRILL AND MEMORIZATION

In Lesson 41 reference was made to the old controversy between Interest and Discipline. Drill and memorization have on the whole come to be considered essential elements of the latter doctrine. This is not strictly fair. Properly conducted drill need not be unpleasant, especially with young children. But whether pleasant or not, it should be insisted upon in certain cases, just because certain bonds must be developed to a high state of efficiency. It is a matter of necessary thoroughness.

Such instruction is different from that given for the sake of discipline, which is instruction given just because it is hard and uninteresting. With the theory behind this—that only by overcoming difficulties and doing what one does not want to do can one develop a well rounded character—we are at present not much concerned. The inclusion of Latin and mathematics in the curriculum has often been defended on just this basis. If it is essential that one do what one does not want to do then the difficulties intrinsic to the subject matter of such studies may be properly insisted upon. If, on the other hand, the overcoming of obstacles is sufficient discipline then it would seem that the student may develop even through work which he likes.

In the development of a hierarchy of habits the learner very often reaches certain levels where no noticeable improvement occurs, sometimes remaining on the plateau for long periods of time. Investigators of this subject affirm that rise from a plateau occurs only when the learner is doing his best—when he feels like doing the work and exerts himself. Very often the rise does not occur until some accident happens. For example, a telegrapher is given an opportunity to obtain a better position, if he can increase his sending and receiving rate. And in a few days he does increase them beyond what he has ever done before. Every man has resources which he never draws upon because he does not sufficiently desire to do so. It would seem that pressure must be put upon most persons before they can reach levels of proficiency which, when once reached, they easily

maintain. Not only do they maintain such increased proficiency, but they also seem to enjoy their work in direct ratio to their proficiency.

Proper drill and memorization are essential for good reasoning and the development of initiative. This point has already been made in Lesson 39. Reasoning is a trial-and-error manipulation of previous experiences. If one has few experiences, or if they are vague or poorly analyzed, one's reasoning must be sadly limited. If, on the other hand, one's experiences are extensive, clean-cut, and well analyzed into details, then one's reasoning may be efficient. Memorizing of facts and making fine distinctions between facts are ways of supplying the mind with material to work on in solving difficulties.

The most formidable attack upon memorization has been provoked because too many teachers have demanded slavish reproduction of the text and nothing more. Three graduates of a two-year normal school requiring High School graduation testified that the only method they had ever used in studying was to read each sentence through three times as they went through their lessons! In such cases there is no question as to the superiority of reorganization of lesson material over mere memorization. What is needed is that students shall *think through* a text-book assignment, not memorize it. This may involve their underlining essential points, or outlining the lesson, or asking themselves what its points are, why they are presented, etc. The student who merely memorizes the material can answer only such questions as are intimately related to it—can give back only what is memorized. The student who has reorganized the text can utilize portions of it, disregarding other portions, and can utilize these portions in thinking out the answers to problems quite remote from the original connection. Then, to master the contents of a lesson, only one step more is needed: the memorization of the main elements, or of any important laws, definitions or specific facts, so that these can be fluently presented. Seldom does one hear a well-rounded recitation today. All that is heard is piecemeal presentation of the subject in response to many questions. Just a few minutes more of study spent in memorizing the outline would supply the deficiency. But it will not be given by students until it is required by instructors.

LESSON 48

TO WHAT EXTENT CAN TRAINING GAINED IN ONE SITUATION IN LIFE BE UTILIZED IN ANOTHER?

If I train myself to cross out 4's on a sheet of paper containing a large number of digits, will that help me to cross out 6's or 7's? If I am drilled on noticing flowers until I come to know most of the flowers about my home, will that aid me in noticing birds, or different kinds of soils, or detecting differences in the weave of cloth? If not, why not? If so, to what extent and how?

The specific problem is to determine (1) whether practice in canceling 4 and 7 aids in canceling 6, or combinations containing 2 and 3, where the same kind of blank is employed, or canceling 0's where another blank is used; and (2) whether practice in canceling 4 aids in canceling 7.

Apparatus.—One Woodworth and Wells Number-Checking Blank, ten Woodworth and Wells Number-Group Blanks,[1] Stop-watch.

Procedure.—Let that one of the two partners who has the better eyesight act as S.

All blanks are cut in two so that each half of the Number-Group Blank has seven columns of 12 groups of figures each. Arrange them so that S will mark alternately a top and then a bottom section throughout the experiment.

Read over the instructions for each part and then do that part before reading the instructions for the next part. This procedure will save you time in this particular experiment.

Provide for a rest-period of about 30 seconds after each blank so as to lessen eye-strain as much as possible. Most of the blanks will require from 40 to 100 seconds each, thus requiring in all from 20 to 45 minutes.

1. E gives S half a Woodworth and Wells Number-Checking

[1] See R. S. Woodworth & F. L. Wells, Association Tests, *Psychol. Monog.* No. 57, 1911.

Blank, face down. S provides himself with a medium-soft lead pencil. At the signals "Ready," "Go," S is to turn the blank over and beginning at the top of the blank check off all the 0's. He is to pass from left to right as in reading, is to make no errors, is to continue without pause until the blank is completed, and is to finish the test as quickly as he can. Record in fifth-seconds (if possible) the time taken. S should be informed that there are five 0's in each row.

2. Repeat the above.

3. In the same manner S must check off all the combinations which contain the number 6 in half a Number-Group Blank. Here also S is to pass from left to right as in reading, to continue without pause until the blank is completed, and to finish the task as quickly as possible.

4. S now goes through half a blank checking off all those combinations which contain both the digits 2 and 3.

5–12. S now goes through eight half-blanks one after the other, checking off all those combinations which contain the figure 4. Be sure to record the time required to do each of the eight half-blanks.

13. Mark one half blank for the figure 6, i. e., repeat (3).

14–21. Now mark eight half-blanks for the figure 7. Be sure and record the time for each half-blank as in (5)–(12).

22. Mark one half blank for the figure 4.

23. Mark one half blank for the figure 6, i. e., repeat (3).

24. Mark one half blank for all those combinations containing both the figures 8 and 9 in the same group.

25. Mark the first half of a Woodworth and Wells Number-Checking Blank for the figure 0. Remember here again that there are five 0's in each row.

26. Repeat procedure in (25).

Results.—Record opposite each trial (a) the time taken, (b) the number of omissions or incorrect cancellations, (c) the computed time (including time and errors), (d) any introspective observations, (e) any interesting observations by E as to S's methods of work, general attitude, etc.

(Each half of the blank contains 56 groups containing any special digit, and 35 groups containing any specified two digits. 2% of the total time for any blank should be added to the total time for each omission or wrong cancellation when one numeral is

being checked. When two numerals are being checked add 3% for each error).

(Canceling 4 and 7 are on the whole equally difficult, as is also canceling the pairs (2 and 3) and (8 and 9.)

Plot the results, indicating along the horizontal axis the successive trials from (1) to (26) and along the vertical axis the computed time for each trial (i. e., actual time plus additional time for each error).

Make the following comparisons:

(*a*) The time for marking O in the four cross-section tests. Compare the four records with those obtained from fifteen persons who canceled only the four half-blanks and did not obtain any practice effect from canceling other blanks. Such persons are referred to as the *control group*. Their data are: 64.4″, 58.1″, 55.0″, 54.8″, respectively. The necessity of comparing the data in the experiment with "control data" is, of course, due to the fact that there will always be considerable improvement in each process due to *practice effect*. A second blank will naturally be done more quickly because proficiency will have been gained through doing the first blank. This gain due to practice must first of all be calculated and subtracted from the total gain, before we can consider any transfer effect. This is done by subtracting the improvement shown by a control group from the trained group.

(*b*) The time for marking 6 in the three tests. (Data from Control Group are 80.8″, 72.6″, and 67.9″.)

(*c*) The time for marking 2 and 3 and also 8 and 9. (Data from Control Group are 90.6″ and 91.1″. Canceling 8 and 9 is probably slightly harder to do than canceling 2 and 3.)

(*d*) The time for marking 4 at the end of its practice series and after practicing 7 eight times. (Data from Control Group are 51.7″ and 50.5″.)

(*e*) The rate of improvement in the two practice series, i. e., canceling 4 and 7 eight times each. (Data from the two Control Groups are, for 4's: 64.4″, 61.4″, 58.8″, 58.1″, 57.0″, 54.4″, 54.2″, 51.7″; and for 7's: 62.6″, 57.8″, 56.8″, 56.9″, 56.8″, 53.8″, 52.9″, and 52.4″.)

Questions.—(1) Does training in marking 4 and 7 aid in the marking of 0, or 6, or (2 and 3), or any other figures? Why?

2. Two methods of testing transfer have been used. In the

"cross-section" method one function is tested before and after the training of another function. In the "successive practice curve" method, two performances of equal difficulty are trained one after the other, to see whether the second improves more rapidly than the first. Both methods are incorporated here into the experimental procedure; which is better for solving the problem of transfer?

3. Does training one function improve another function?

4. What is transferred in these experiments? Explain carefully.

LESSON 49

TRANSFER OF TRAINING

The problem before us in this lesson is one of the most fundamental in all education. Upon its solution depends very much of educational policy. At the present time there are practically three solutions.

The first one, known as the doctrine of *formal discipline*, comes down to us from ancient times. Possibly it is as well expressed by Hugh[1] as any one. He says: "Intellectual training stands on very much the same basis as physical training. A man's physical nature can be trained by doing useful work or the exercises of the gymnasium, which have no value whatever except their effect upon the physical system of the performer. So one's brain system can be trained in studies that have a knowledge value for the individual, but also in those that have none. In both cases, of course, it is best that the gymnastic should be secured in the performance of useful work, as in this case two ends are gained at the same time; but as, perhaps, all kinds of work only partially develop one's physical powers, so that it is necessary to have recourse to gymnastics to complete the physical training, in the same way it may be necessary to have special exercises to develop particular brain functions, though such exercises have no knowledge value in themselves." Thorndike[2] has stated the belief of the adherents of this view as follows: "It is clear that the common view is that the words accuracy, quickness, discrimination, memory, observation, attention, concentration, judgment, reasoning, etc., stand for some real and elemental abilities which are the same no matter what material they work upon; that these elemental abilities are altered by special disciplines to a large extent; that they retain those alterations when turned to other fields; that thus in a more or less mysterious way learning to do one thing well will make one do better

[1] D. D. Hugh, Formal Education from the Standpoint of Physiological Psychology, *Ped. Sem.*, April, 1898, p. 604.

[2] E. L. Thorndike, *Educational Psychology*, 1913, Vol. II, p. 363.

things that in concrete appearance have absolutely no community with it."

This "formal discipline" point of view is not supported today by the great majority of psychologists or by many educators. On the other hand certain other educators uphold it, and it represents the point of view of the populace, including numerous school teachers.

The second solution is a *very narrow interpretation of the theory of "identical elements"* which developed from the early experiments of Woodworth and Thorndike. According to this view there can be no transfer from one experience in life to another unless there is an identical situation-bond-response combination common to both. Various ardent supporters of the first theory have written and talked as though this narrow interpretation were the one upheld by modern psychology.

The third solution is a *broad interpretation of the theory of "identical elements,"* possibly best presented by Ruger[1] or Heck.[2] Here it is emphasized that transfer may take place in terms of identical elements in the *actual tasks*, and also in terms of identical elements involved in the *method* of going at the tasks or in the *attitude* of the individual toward his work.

The first point of view practically means that any course of study that requires effort will help the student to do any task he encounters in life. The second would insist that only as the course of study has actual elements in it that are common to the task in later life can the former be of assistance in the latter. The third would include the second but would also go beyond it, in asserting that school training in methods of going at a task or in developing proper attitudes toward work is of help in later life. For example, if a student learned in arithmetic to conquer a self-conscious attitude and to substitute for it a problem attitude towards his work, this would be of value to him throughout life because the common element—problem attitude—would be, or might be, present in all activities.

With this general statement before us let us note the results from two experiments and then return and take up these various solutions and consider them in detail. After that we shall be ready to consider their applications to education.

[1] H. A. Ruger, *The Psychology of Efficiency*, 1910.

[2] W. H. Heck, *Mental Discipline and Educational Values*, 1912.

Experimental Results

Results From the Experiment in Lesson 48.—Data from 37 students are given below regarding transfer effect upon canceling 0; also regarding transfer effect from canceling 4 upon canceling 7.

Canceling 0

No. of blank	Control record, seconds	Group gain, seconds	Transfer group: Record, seconds	Transfer group: Gain, seconds	Gain probably due to transfer seconds
No. 1	64.4		63.6		
No. 2	58.1	6.3	59.8	3.8	
			22 intermediate trials		
No. 25	55.0	3.1	52.5	7.3	(4.2)
No. 26	54.8	0.2	49.7	2.8	
Total gain	....	9.6	....	13.9	4.3

Canceling 4 and Canceling 7 Compared

No. of blank	4's, seconds	7's, seconds	Difference, seconds
No. 5 and No. 14	62.6	56.5	6.1
No. 6 and No. 15	57.8	52.6	5.2
No. 7 and No. 16	56.8	52.8	4.0
No. 8 and No. 17	56.9	53.1	3.8
No. 9 and No. 18	56.8	51.6	5.2
No. 10 and No. 19	53.8	50.6	3.2
No. 11 and No. 20	52.9	51.9	1.0
No. 12 and No. 21	52.4	52.0	0.4
Total gain	10.2	4.5	

The gain probably due to transfer has been calculated as the difference in total improvement between the trained group and the control group. In this way specific fluctuations in the learning curves are largely eliminated from consideration. From the

results it would appear that the training due to canceling twenty two other blanks has aided in canceling 0 on another form of blank to the extent of 4.3 seconds. This approximately represents the gain in doing the second blank over the first blank when no practice intervenes.

Besides such results obtained by the "cross-section" method, we have the data obtained by the "successive practice curve" method in canceling 4 and 7. The gain from canceling 8 blanks of 4 has resulted in the first blank of 7 being done in 6.1 seconds less time than the first blank of 4. But this gain is slowly lost as successive blanks in the two series are compared until in the case of the 8th blank there is only a difference of 0.4 seconds between canceling 4 and 7. Apparently we may gain something from canceling 4 that will help us at the start in canceling 7 but this transfer effect does not help us particularly in later trials. After canceling 8 blanks a person may expect to do as well in canceling 7 who has had no experience in canceling 8 blanks of 4 as one who has had that experience.

Interpretation of the Results.—The writer holds to Thorndike's doctrine of "identical elements" but these elements must be construed in a broad sense. It is not enough to consider that the "identical elements" in canceling 4 and 7 are only situation-bond-response combinations involved in the actual process of seeing a 4 and canceling it or seeing a 7 and canceling it. Other combinations of various sorts are involved in such a process. The method of holding the pencil, the method of making the check mark, the method of holding the paper with the left hand, all these and many other details, enter into the total processes of marking 4 or 7. And in addition there are other groups of habits, such as, willingness to cooperate in a seemingly senseless performance, determination to do one's best, etc., that play a very great part in executing any task.

We maintain that there can be no transfer from training in one function to that of another unless there are identical elements common to both processes. This point will be discussed more fully after the experimental data have been considered. The data in this experiment support this point of view. The transfer in the case of canceling 0, or 6, or 2 and 3, or 8 and 9 is very small although 18 to 22 intermediate blanks have been canceled. It probably does not exceed what would be obtained through cancel-

ing three or four more blanks of the test material itself. And in the case of the last table it is clear that the transfer gain does not vitally affect canceling 7 after the first few trials have been completed. What has been transferred here is not ability in "seeing a 7 and canceling it" because of training in "seeing a 4 and canceling it" (these not being identical situation-bond-response combinations), but rather the methods of holding the pencil or paper, of making the cancelation mark, or in general adaptation to the whole performance—an improvement in functions common to both processes.

The Experiment of Poffenberger[1]

"The general plan of the experiment was as follows: Eight subjects, and in some of the tests eleven, repeated each of a series of seven tests, five times. Four of these subjects were then selected as a training group while the others became the control group. The training group was practiced in each of another set of four tests for 100 times. This training continued for a period of nine days with approximately eleven tests each day. On the tenth day, the combined group of trained and control subjects was again tested in the seven tests used at the beginning of the experiment. Five trials were given as at the start. Hence, we may compare the performance of a group who had nine days of special training with a group which had no special training during this interval."

Poffenberger secured subjects "who were familiar with psychological tests and who in most cases had had experience with the very tests used." "The first two trials in the first and last test series in the case of both the trained and the control groups were considered as preliminary and not to be calculated in the results." In these and other ways he eliminated the general factors which made up the bulk of the transferred improvement, such as "adaptation to the conditions of the experiment, acquaintance with the material, distribution of attention, etc."

The results may be grouped in three parts: First, cases in which there were no identical elements common to the test material and the training material; second, cases in which there

[1] A. T. Poffenberger, Jr., "The Influence of Improvement in One Simple Mental Process upon Other Related Processes," *Jour. of Educational Psychology*, Oct., 1915.

were identical elements common to both; and third, cases in which there were identical elements in both situations but the expected responses were different, thus constituting cases of interference.

First.—"Where there were *no identical bonds* between stimulus and response in the two processes, the influence of one test upon another will be neither positive nor negative, i. e., there will be neither transfer nor interference." In the first experiment, the test consisted of calling out as rapidly as possible the names of forms printed on a sheet of paper, i. e., seeing a □ and saying "square," seeing a ○ and saying "circle." The intermediate training consisted of seeing squares of various colors and calling out the names of the colors,—i. e., seeing the color red and saying "red," seeing the color blue and saying "blue." In the second experiment, the test consisted in canceling groups containing both 4 and 7 on a Number-Group Blank. The intermediate training consisted of canceling 3 and 5 alternately fifty times each on a Number-Checking Blank. In the third experiment, the test consisted in subtracting 17 from fifty numbers. The intermediate training consisted in adding 17 to fifty other numbers for one hundred times. The fourth experiment consisted in dividing twenty-five numbers by 7, while the intermediate training consisted in adding 7 to fifty numbers for one hundred times. The table gives the amount of improvement for the Control and Trained Groups.

TRANSFER EFFECT WHEN NO IDENTICAL ELEMENTS ARE PRESENT

Tests employed	Intermediate training	Improvement	
		Control group, seconds	Trained group, seconds
1. Naming forms.	Naming colors.	15.9	15.0
2. Canceling groups containing both 4 and 7.	Canceling 3 alternately with 5.	15.1	8.8
3. Subtracting 17 from fifty numbers.	Adding 17 to fifty numbers.	19.5	21.3
4. Dividing twenty-five numbers by 7.	Adding 7 to fifty numbers.	6.0	−2.2
		14.1	10.7

Second.—"Where there are *identical elements* in the two situations or where a given process involves one or more bonds previously formed, there will be a positive or transfer effect." In the one experiment, included here, the test consisted in canceling groups containing both 3 and 5 on a number-group checking blank. The intermediate training consisted in canceling 3 and 5 alternately fifty times each on a number-checking blank. In the training, consequently, the individual developed the habit of seeing 3 and canceling it, and of seeing 5 and canceling it. These habits formed part of the process of looking for groups containing both 3 and 5 and therefore transferred to the test performances. The table gives the amount of improvement for the Control and the Trained Group.

TRANSFER EFFECT WHEN IDENTICAL ELEMENTS ARE PRESENT

Test employed	Intermediate training	Improvement	
		Control group, seconds	Trained group, seconds
1. Canceling groups containing both 3 and 5.	Canceling 3 alternately with 5.	11.5	23.7

Third.—"Where one test necessitates the *breaking of previously formed bonds* and the formation of new ones, there will be a negative effect or an interference." In the first experiment under this heading, the test consisted in responding to each of a list of adjectives by naming a noun that could go with it appropriately, as ugly—dog, lazy—tramp. The intermediate training consisted in responding to the same list of adjectives by naming their opposites, as, ugly—beautiful, lazy—industrious. In the second experiment, the test consisted in multiplying various numbers by 7, whereas the intermediate training consisted in adding 17 to the same numbers. In both these experiments, the situation was identical in the test and the training series, but the responses were different. Interference is consequently to be expected.

TRANSFER EFFECT WHEN INTERFERENCE EFFECTS ARE PRESENT

Tests employed	Intermediate training	Improvement	
		Control group, seconds	Trained group, seconds
1. Responding to adjectives by naming nouns that could go with them.	Responding to the same adjectives by giving opposites.	15.6	−2.0
2. Multiplying fifty numbers numbers by 7.	Adding 17 to the same numbers.	29.7	11.4
		22.7	4.7

Summing up Poffenberger's experiments we see that (1) when there were no identical elements in the two processes there was no transfer; (2) when there were identical elements in the two processes there was transfer; and (3) when there were identical situations but diverse responses there was interference.

Discussion of Experimental Results

For the sake of clearness the points already established will be repeated again. First, *without identical elements in the two performances there can be no transfer; with identical elements in the two performances there may be transfer* (we shall consider later why there is not always transfer under such conditions); and *with identical situations present to be associated with different responses there will be interference.*

Second, *these identical elements are to be thought of as habits, i. e., as situation-bond-response combinations.*

Third, *an identical element may be an integral part of the functions themselves, or a part of the process by which the learner developed facility in performing the functions.* For convenience we may speak of identical elements of *content* (where it is an integral part of the processes themselves), or of *method*, or of *attitude.* The last two refer to elements entering into the process of developing the new habit under consideration. To illustrate these distinctions, consider the case of a child learning long division. Identical elements of content would be all the specific habits of addition, subtraction, multiplication and short division

already known; also the simple habits of writing digits, of drawing lines, of comprehending the value of unit's place, ten's place, etc. Identical elements of method are also habits, but habits of a broader sort. They could be illustrated here, e. g., by a habit of juggling with figures until you get the right answer, by a habit of juggling with figures until you get an answer without any remainder (a bright child, when first studying long division, quickly sees that all answers come out even), etc. Identical elements of attitude would be also just as much habits as the others, but habits pertaining, so to speak, to the control of energy. One boy, for example, has done well in multiplication and has gained a confident attitude toward his arithmetic work; consequently, he expects to do well here, he tries hard, he throws himself into the task. Another boy has had trouble in his arithmetic right along; he has no confidence in himself. He consequently does not throw himself into his work. He really does not know how to do it.

The first solution of the problem as "to what extent one can utilize training gained in one situation in life in another situation" was not conceived at all in terms of *habits*. It was supposed that "memory" and "discrimination" were analogous to muscles. If they were trained on any sort of material, they were trained, and so could be utilized on any other material. We realize now that this old "faculty-psychology" idea was wrong. "Memory" and "discrimination" are only generic terms referring to phases of habits. Seeing a 4 and canceling it is a habit, and it is a different one from seeing a 7 and canceling it; training the first does not train the second, even though both do involve "memory" and "discrimination."

The *second* solution emphasized only habits of *content*, and overlooked habits of method or habits of attitude. The *third* solution, on the other hand, takes into account all three types of habits.

With an adequate understanding of the third solution, one sees that the educators who have supported and are still supporting the first solution are not very wrong from their point of view; but their psychology of the processes involved is false, and so they put the emphasis in the wrong place. For them the big thing in education is the development of what we should call habits of method and habits of attitude. And we heartily agree with them here. They have seen these habits developed in

themselves or in their pupils through study of the classics or mathematics, and naturally give the credit to these courses of study. Just here we take issue with them. It is not the *course of study* that is responsible for the development of habits of method or attitude, but the *method of instruction*. Now, the method of instruction depends partly on the instructor and partly on the student. Our educators today are superior men who have developed adequate methods and attitudes because they have had the ability to do so. Moreover, among the teachers whom they had in school, the most inspiring were usually those who taught the classics and mathematics, so that these men, as students gained most from those subjects. And they tend to believe that the benefits were derived from the *subjects*, rather than (as is more probably true) from the personality and methods of the teachers. The important thing is to develop proper methods and attitudes of attacking new situations in life. Such development can come—and ought to come—as well from studying one subject as from studying any other. (This point will be considered shortly.)

There is one other point on which we differ with those who support the first solution. We would absolutely deny that the *ideal* college education is one such as President Hadley[1] of Yale had in mind when he said, "It may be objected that any such arrangement would render it difficult for a boy to study the particular things that he was going to use in after life. I regard this as its cardinal advantage. The ideal college education seems to me to be one where a student learns things that he is not going to use in after life, by methods that he is going to use. The former element gives the breadth, the latter gives the training." Youmans[2] characterized thus the difference between this school of thought and the position maintained here: "The adherents of the current theory propose to learn first the useless fact, A, to get the discipline necessary to acquire the useful fact B (later in life); while a rational system ignores useless fact A and attacks B at once, making it serve both for knowledge and discipline . . . As it costs as much effort to learn a useless fact as a useful one, by this method half the power is wasted."

It is just because of this point that the supporters of the third

[1] A. T. Hadley, *Report of the President of Yale University*, 1908–09, p. 22.

[2] E. L. Youmans, *Culture Demanded by Modern Life*, 1867, p. 23.

solution have so fiercely attacked the classics in recent years. "The child is learning useless facts," they assert. "Let him learn useful facts instead." Development of methods and attitudes can come equally well from all subjects providing they are well taught. At the present time most of us are living in glass houses, and it scarcely behooves any of us to throw stones. Freshman English and Elementary Psychology were the most barren subjects in the writer's college course, barren because there was practically nothing in either which touched life in any way. Although the author feels that a child cannot afford to study Latin because it uses time which might better be given to studying other more useful subjects, yet in many a school today the most useful course is the Latin course—and this is simply because in such cases the Latin teacher happens to be the best teacher in the school with respect to methods and inspiration. The remedy is (1) better teaching and (2) courses of study developed out of the experiences of the child.

In estimating the comparative value of two courses of study one should consider particularly the transfer that is possible from the two to life—not solely to the earning of a living, but in addition, to real enjoyment of life and to usefulness as a member of our social order. And this transfer must be thought of in terms of the content of the course, the methods developed, and the attitudes acquired in the course. For example, Freshman physics was a very worth-while course to the writer because in it he learned to think in terms of formulae. Possibly he should have gained that method of handling material from his mathematics courses, but he did not. And he did get it in the physics course, and he now uses the method frequently in his thinking. One of the most serviceable studies he has ever made is that of advertising—a course that as a student in college he could not have got credit for because "it might have helped in earning a living." It vitalized his understanding of rhetoric and the writing of English because in advertising one must write clearly and *forcefully*. It carried him into the realm of art because a successful advertisement must be artistic. His psychology became organized along new channels because it was necessary to present the subject in an actually useable way. It forced him to study some economics, to come into contact with business men, to understand many phases of business life that otherwise would have remained unexplored.

In the same way every part of a course of study should be tested out. And in all but advanced courses for experts, details which are not useable in life should be discarded, and details which do pertain to life put in their place. As most details can be shown to have a bearing on other things this rule will operate not so much to determine what should go in a course and what should be eliminated, as to emphasize the manner of presentation. Let the man with a hobby retain his hobby provided he justifies its existence in his course by linking it with many things in life—the life which has to do with earning a living (for that must come first), plus the life of appreciation, enjoyment and service.

How to Teach so as to Secure Transfer

Let us turn from a discussion of the nature of transfer in general to a consideration of some steps which are essential to securing the most widespread transfer from one performance to others. Consider first an experiment reported by Judd[1] and then its bearing on this point.

Two groups of boys were trained to hit a target under water. "To do this, when the target is looked at obliquely from above, is a task requiring some readjustment of the boy's ordinary habit of throwing a dart, because the light which comes from the target is refracted as it leaves the water and, as a result, there is an apparent displacement of the target. Furthermore, the amount of apparent displacement will differ when the depth of the water is changed. . . . The one group was allowed to acquire experience without any instruction whatsoever. They were simply set at the task of hitting the target. The second group was given a preliminary explanation of what is meant by refraction and how the apparent displacement of the target is produced. The explanation thus given to the second group constituted the only distinguishing characteristic between the two groups. It may therefore be said that one group had the theory of the situation, while the other had no theoretical training.

"The result showed that the two groups of boys required the same length of time to learn how to hit the target under water. This first result of the experiment shows with perfect clearness that one cannot substitute theory for practical experience. (New muscular movements or new coordinations of movements

[1] C. H. Judd, *Psychology of High School Subjects*, 1915, pages 269–271.

must be learned through 'random movements.') One can know something about refraction, but if he has to deal with it he must learn to make his readjustments to the practical situation by actual readjustment of his movements, and this actual readjustment of his movements apparently will take place at a no more rapid rate than it does for any intelligent person who starts out to accomplish the practical task. In terms of our earlier discussion it may be said that the theory of refraction had to do with the visual part of the total experience. An analysis of the visual facts could not be carried over directly into hand movements hence the time required in making the hand adjustment was not produced through a preliminary analysis of the visual facts.

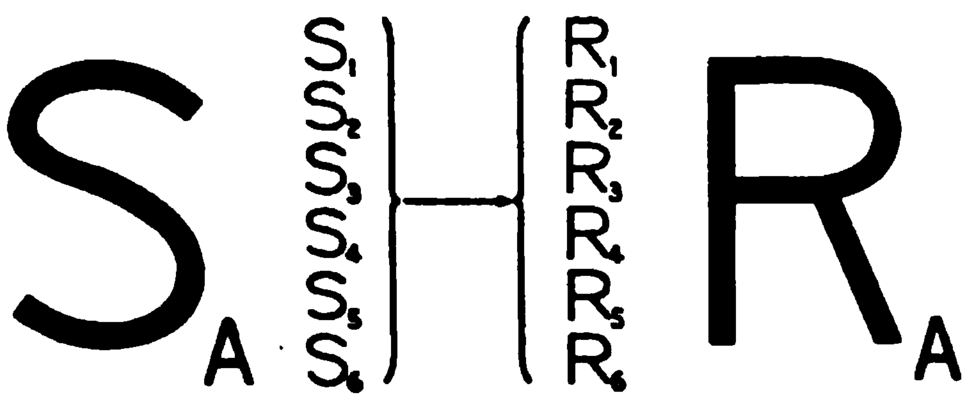
"After both groups of boys had thus mastered the practical situation the experiment was modified by changing the depth of water. This change in the depth of water, followed, of course, by a change in the apparent displacement of the target, turned out to be a source of very great confusion to the boys who had had no theoretical training. They had learned how to deal with one situation in which the target was under water, and they had at the outset of the experiment such natural experiences as any boy brings to a task of this type, but the new situation produced by changing the depth of the water did not correspond to either of these sets of experiences which they had mastered. They consequently oscillated between the newly acquired experience with the first depth of water and the earlier, natural experience, which had nothing to do with water at all. . .

"As contrasted with these boys who had no theoretical training the group of boys who knew the theory of refraction presented an entirely different result. These boys adapted themselves rapidly to the new depth of water. . . . In other words, after they had mastered one practical situation and had comprehended it in the light of their theoretical knowledge, they were able to take up rapidly and with all of the advantages of earlier experience a new problem which involved both practical adjustment and analysis."

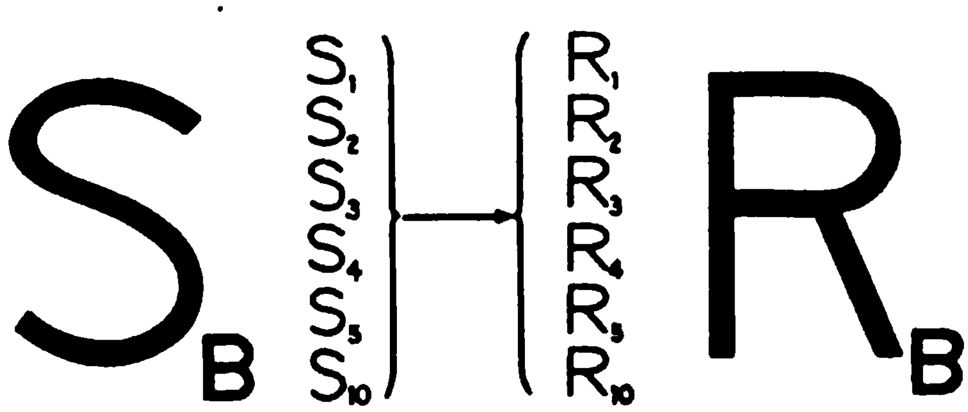
In terms of identical elements the untrained group of boys developed a specific response to a specific situation. Later when the situation was changed they had to go to work and develop another specific response to the new situation through random movements. This is the method by which nearly all persons

learn to spear frogs or fish. In the case of the trained group, when they were confronted by the second situation they added to the actual situation the additional element pertaining to refraction of light. Consequently after missing the first shot, they reacted to their training by making to themselves some such statement as this,—"I missed that shot and yet fired as I ought to have. Evidently the object is deeper in the water than I thought. If so, I must make more allowance next time for refraction." Understanding of refraction constituted another element in the total situation to which the trained boys reacted.

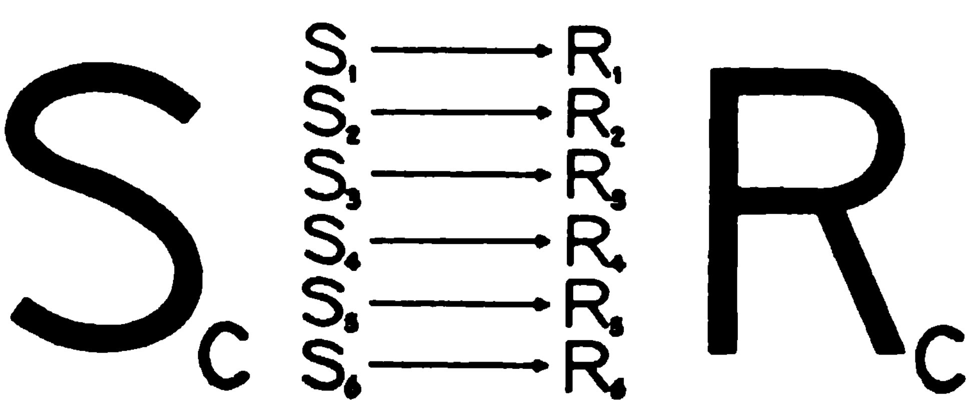
Judd would substitute the term "generalization" for "identical elements." As far as the writer can determine, his conclusions agree with these recorded here. Generalization means, apparently, understanding the details in their relationship to the whole process and better still in their relationship to many processes. By generalizing we learn to react not to the situation as a whole but to it in terms of its parts. For example, diagrammatically, a response to a whole situation like this



would not aid one in responding to this



But a response to the situation in terms of its parts, like this



would aid very greatly in responding to this

$$S_D \begin{array}{l} S_1 \longrightarrow R_1 \\ S_2 \longrightarrow R_2 \\ S_3 \longrightarrow R_3 \\ S_4 \longrightarrow R_4 \\ S_5 \longrightarrow R_5 \\ S_{10} \longrightarrow R_{10} \end{array} R_D$$

In the first two cases there are no identical elements, so far as the individual who is reacting is concerned—there are simply specific responses R_A and R_B to specific situations S_A and S_B. But in the latter two cases there are the identical elements, S_1—R_1, S_2—R_2, S_3—R_3, S_4—R_4, and S_5—R_5. Consequently R_D will be made in terms of these identical elements from R_C. How R_D will come to include a reaction to the new element S_{10} will depend upon whether S_{10}—R_{10} is known from other experiences or is a new movement which must come through trial-and-error learning.

Some examples of just such propositions are these: When a person who is used to driving an auto first attempts to steer a motor-boat, although both are guided by turning a wheel and are guided in essentially the same manner, there are a few random movements that have to be made before the process becomes thoroughly learned. These random movements occur because the two wheels are not the same size and an eighth turn on one does not correspond to an eighth turn on the other, etc. The differences in the two performances are learned only through random movements. The common elements in the two are carried over from the auto to the motor-boat. A boy who has ridden a velocipede will learn to ride a bicycle more quickly than one who has not had this experience. Why? Because he has learned to make his feet go while guiding with his hands, and again, to steer where he wishes to go by turning the handle bars. Both these elements are common to the two performances. Having learned them on the velocipede is sufficient; he need not learn them over again. But there was practically no problem of balancing himself on the velocipede, whereas it is a very real difficulty on the bicycle. Hence, this element will have to be learned in progressing from the velocipede to the bicycle. And this element must needs be learned through random move-

ments. And not only must this element be so learned, but the coördination of the new element with the old elements will have to be learned through random movements. *Transfer can take place only when there are identical elements in the two processes.*

But this does not mean that there will necessarily be transfer in the two processes. The identical elements must exist in terms of habits which a person has himself acquired. In other words, if the habit comprises a gross reaction to a total situation, then there can be transfer only when a new situation is encountered exactly like this former situation or containing this as one of its elements. But if one understands just how each part of the response fits into the whole, just why each part is necessary, etc.—in other words, reacts to details of the situation with specific responses, then, when any one of these parts of the situation is encountered again it may be reacted to immediately because there is already a bond between it and its appropriate response.

This leads us to another way of stating the superiority of learning material through reorganization over learning through memorization. Consider the case in which one child draws up an outline of a chapter of geography and another memorizes the material in the chapter. The latter has reacted to the whole chapter with practically one response—memorizing it. Questions based on the wording in the text can be fairly well answered, —surprisingly well if they call only for reproduction of the chapter; poorly, if the questions require comparisons of various sections. But such a student has not formed reactions to the various parts of the chapter and consequently will not utilize the material elsewhere in life, for there is practically no occasion for reproducing a chapter on the geography of Africa, as such. But the first child, on the other hand, in making his outline has been forced to react to details, to react to them in many ways. And he will utilize these reactions in other situations in life when these details are presented, e. g., questions as to the products of Cape Town, European colonies in East Africa, etc. He will utilize his geographical information because he has formed specific bonds between certain details and many others; and in life, these details appear as parts of new situations, not as total chapters.

Judd's experiment is another illustration of this same point. The trained boys have one more detail in the situation associated

with a response than the untrained boys. In occasions when this detail is a part of the situation they can react to it and so come nearer to getting the required new response than can the untrained boys.

Take the case of the Tri Trix puzzle, shown in Plate XII. What is needed to solve this puzzle is to have the puzzle in some way or other suggest the response of twirling it. For most people the puzzle as a whole—or even the parts into which it may be broken—never suggests twirling, and so they fail to solve it. But occasionally to a student there comes in response to the detail "balls must go to the *outside* or *farthest* corners," the response "centrifugal force." When that happens they solve the puzzle, solving it in terms of a transfer of that specific habit from previous experience to this particular puzzle. The reason few of us solve the puzzle is that in physics we formed the bond, "centrifugal force"—"things fly apart." If in the physics course we had proceeded from concrete situations to the general principle, we would have developed the bond "things flying apart"—"centrifugal force." We would then be more likely, when confronted with the puzzle, to utilize the common element "things flying apart."

Summary

Transfer is dependent upon the utilization of identical elements. Identical elements may be much increased by analyzing situations into their parts and learning responses to each part. Generalization of such elements aids greatly in enabling the student to react to the part-situation as distinct from the whole. For example, it has been shown experimentally that training children to produce neat papers in arithmetic will not produce any "neatness" effect in language and spelling papers. But if the element of neatness is analyzed out of a variety of papers so that the child finally comes to appreciate this element as distinct from the total situations in which it occurs, then it may function in any other situation in life. The emphasis must be put upon the word *may;* there is no guarantee that it *will* function. Whether or not there will be transfer depends upon whether the situation encountered in life will arouse the neatness habit, whether (to use the example above) it will call to mind the principle of centrifugal force. In other words, unless generalizations, or central con-

ceptions, are taught so that they will be brought to mind by situations in every day life, they will not function. The best working formula to test out whether transfer will occur from a course of study or a daily lesson is to ask: Is this habit I am requiring my students to develop one that they can use elsewhere? If so, is it being connected up in such a way that situations met in life will cause it to function?

LESSON 50

REVIEW

In order that certain very broad general conceptions may be better established, the writer purposely refrains from summarizing the preceding lessons, and asks that detailed outlines be prepared in which a complete answer will be given to the three questions:

1. Why does one make any given response?
2. How may one influence another to do what is desired?
3. What general principles underlie teaching?

In preparing these outlines do not overlook the material covered in Lessons 1 to 30. But such material may be summarized under broad headings. The material in Lessons 31 to 49 should be outlined in detail.

The aim of this review is, of course, to build up general conceptions through the student's own reorganization of the entire course. In this way each part becomes closely associated with the other parts and consequently made more usable afterwards.

LESSON 51

GENERAL INTRODUCTION TO SOME PHYSIOLOGICAL ASPECTS OF PSYCHOLOGY

So far in this course we have been content to describe human behavior as a response to a situation, including in this conception the thought of a bond which connects the situation with the response. We have now reached a point where it is necessary to scrutinize these three terms and see to just what they actually refer. It is evident, when we come to think about it, that, in the case where some one says "4 and 6" and I answer "10" there is no material bond of any sort which connects the "4 and 6" and the "10." A "situation" and a "response" are not connected together with a "bond" of iron, or wood, or of flesh. How then are they connected together? And what is this "bond" we have so freely talked about? In order to answer these questions and many others of like nature we shall have to turn to the science of physiology for help. We shall have to do this because the process of hearing the "4 and 6" pronounced is a process depending upon the functioning of the ear; also my answering with the word "ten" is a process of moving my mouth and throat; and third, there is a process, it is clear, by which my mouth is made to move after my ear has been stimulated. This last process is due to the functioning of nerve cells which connect my ear with my mouth and throat. Now the science of physiology has for its field of investigation such phenomena as these processes just mentioned and consequently if we wish to understand them more thoroughly we shall have to study its findings.

In this digression from psychology to physiology we shall have but three main problems before us. They are: First, *what is the mechanism by which stimuli affect us?* Second, *what is the mechanism for making responses?* And third, *what is the mechanism by which a stimulus is connected with its response?* All of this information is needed in order that we may understand better just how situations in every day life can, and do, produce certain responses.

In order to get a bird's eye view of this material let us consider one example in a general way. It is not meant that you should grasp and understand all the details of this example—they will come after the following sections have been covered—but rather that you shall obtain an idea of what the whole problem is about. In Plate XLI is illustrated in the simplest way possible the action which results when a pin is stuck into one's skin. "The pin being stuck into the skin of the arm" (at B) can represent the stimulus; "the arm jerked away," represented here by one muscle (C) is the response; and the two nerve cells, one extending from B to L and the other from E to C form the bond.

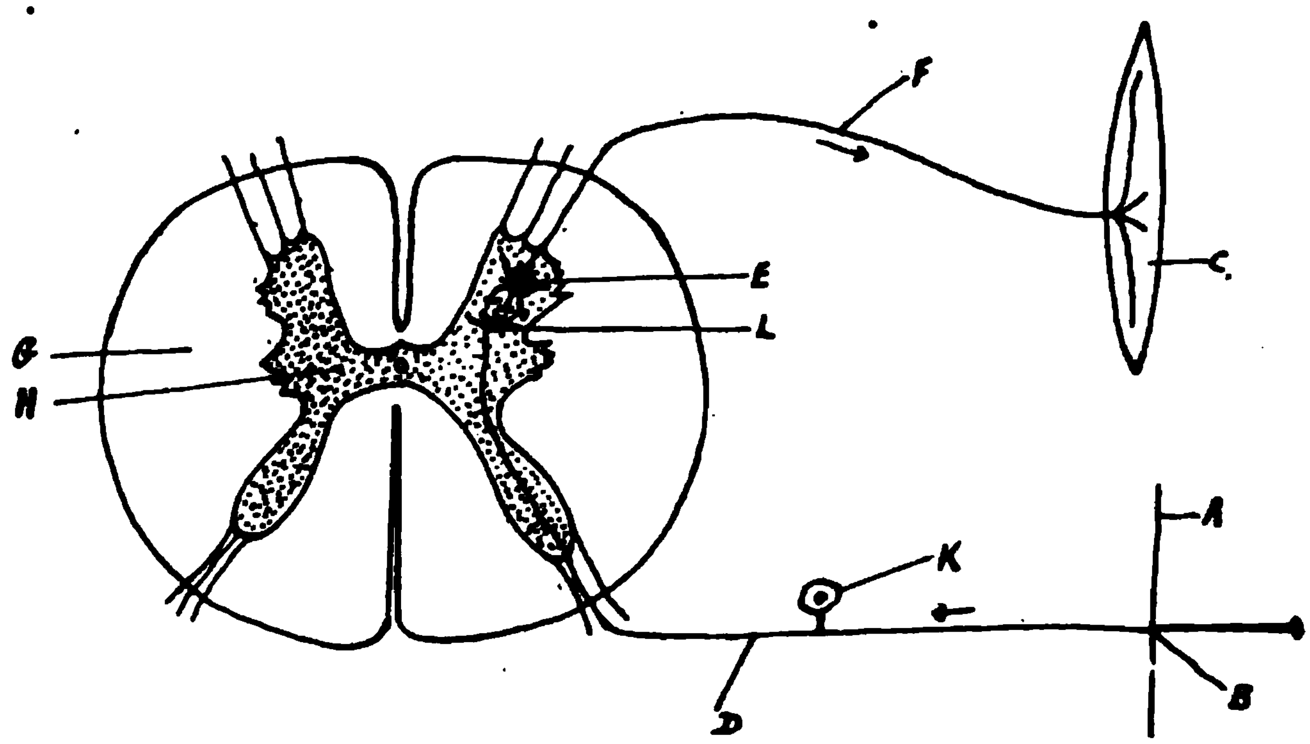


Plate XLI.—Diagram illustrating the simplest form of reflex action. The line A represents the outer surface of the skin being pricked by a pin at the point B. D is the sensory nerve-fibre extending from B into the spinal cord and ending in contact with branches from the motor nerve-cell (E). F is the motor nerve-fibre extending from the motor nerve-cell (E) to the muscle (C). G is the white area in the spinal cord and H the gray matter. K is the sensory nerve-cell of which D is a part.

Stimulation at B passes over the sensory nerve-fibre to L, jumps the gap to the motor-cell (E) and then passes over the motor nerve-fibre to C causing the muscle to contract.

When the pin is stuck into the skin one or more pain-spots in the skin at that point are stimulated. This nervous stimulation travels over the nerve pathway into the spinal cord. At L the current jumps a tiny gap to the second nerve cell. The stimulation then proceeds from the spinal cord over this second nerve pathway to the muscles of the arm (represented by one muscle here). The stimulation is thus transmitted to the muscular tissue, causing it to contract and the arm is moved

away. All of the above is called a *reflex act*. The whole thing is done unconsciously and actually is finished before one feels the pain.

THE THREE LEVELS OF NERVE ACTION

The nervous process illustrated in Plate XLI involves a sense-organ (pain spot in the skin), a muscle, and nerve cells connecting the two together by way of the spinal cord. Such a process is

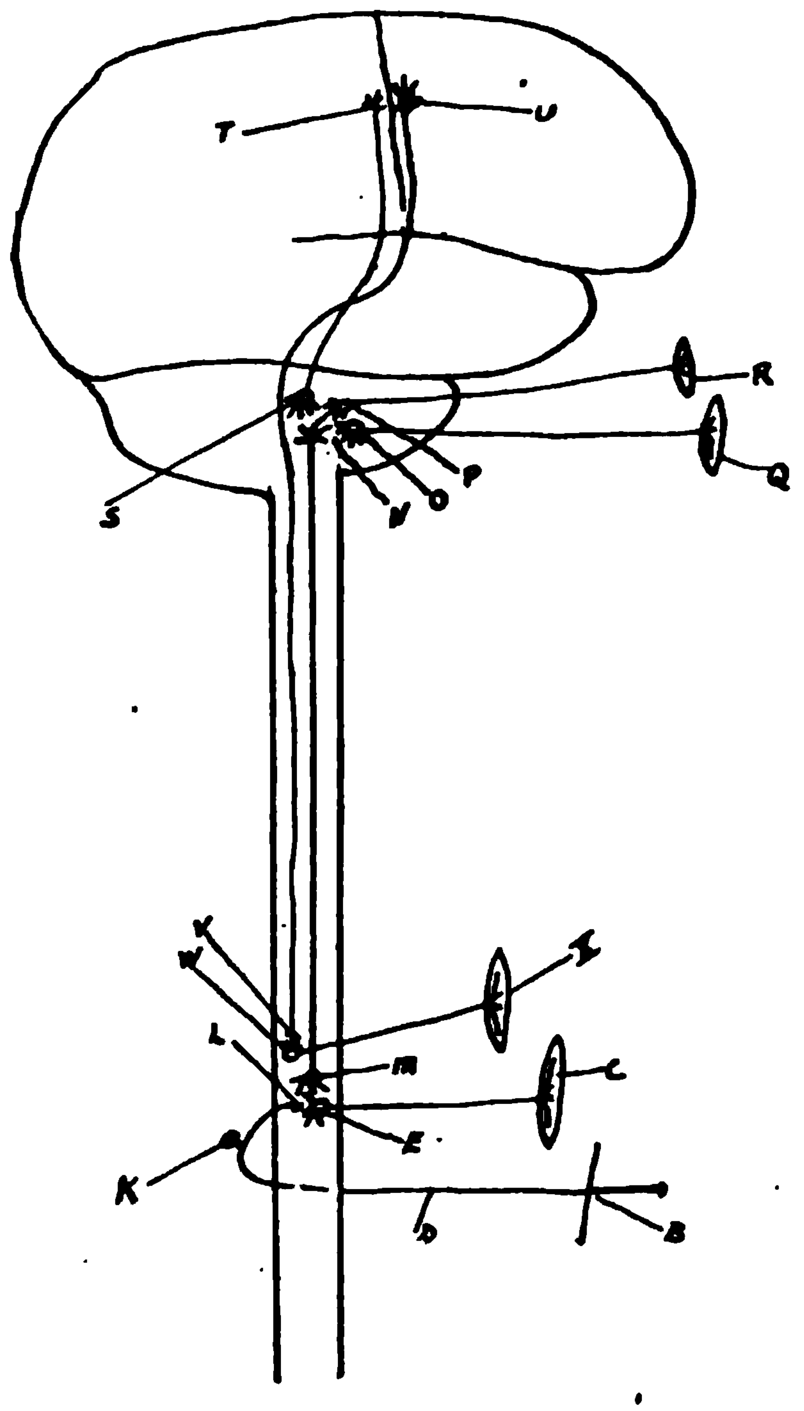


PLATE XLII.—Diagram illustrating in outline form three responses resulting from stimulating the skin by picking it with a pin (at B). In the first case the current flows from B to C by way of D, L, and E, and the hand is jerked away. In the second case the current flows from B to Q and R by way of D, L, M, N, O, and Q or D, L, M, N, P, and R and the eyes are focused on the hurt spot. In the third case the current flows from B to X by way of D, L, M, N, S, T, U, V, and W resulting in a conscious movement of the left hand moved over to rub the hurt spot.

spoken of as belonging to the "spinal level" of nerve action. When the connection between sense-organ and muscle involves the mid-brain it is grouped in the "intermediate level;" and

when it involves the cortex of the brain, it is grouped in the 'cortical level" of nerve action.

The Spinal Level.—Connection between sense-organ and muscle takes place in the spinal cord. Such connection has already been described in connection with Plate XLI. It is also illustrated again in Plate XLII where the stimulation caused by the pin at B causes a current to flow from B to L. Part of this current jumps across the gap to E and then flows on from E to C resulting in the muscle moving (arm jerked away) described above.

The Intermediate Level.—In the illustration in Plate XLII part of the current which started at B and flowed to L jumps the gap to M instead of to E. It then travels up the spinal cord as far as the base of the brain (to the mid-brain). Here part of this current jumps the gap from N to O and part to P (actually to other points too). From O the current flows to a muscle (Q) which helps turn the head and from P it flows to a muscle (R) which helps turn the eye. With the help of many such muscles the eye is focused on the hurt spot. In this case, as in the first one, we have the response without any consciousness at all. Although the spinal cord is involved in this action, the connecting of the sense-organ with muscles is in the mid-brain, not in the spinal cord.

The Cortical Level.—In the third process, part of the current which came up the spinal cord from M to N jumped the gap to S and went on up to the cortex of the brain. Here it jumped the gap from T to U and then started down through the brain to the spinal cord and then down the cord until it came to V. Here it jumped another gap to W and then flowed out over this nerve pathway to muscle (X) and other muscles not represented. They contracted and the left arm, let us say, reached over and rubbed the hurt hand. Now this third process is essentially like the other two in the general description of the nervous action, except in this last case the current flowed for a part of the way through the cortex of the brain. When it does that we are apparently conscious of the process. Due to this third process we know that our hand hurts. No one has ever given a satisfactory explanation as to how or why consciousness is aroused when nerve cells in the cortex are involved but the fact remains that this is so. Possibly this analogy may help us grasp the

general idea, but it is only an analogy after all. Electric current flowing from the dynamo over wires in the street and into our houses does not give off light, but it does give off light when it flows over the tungsten filament in our incandescent lights. In like manner, apparently, it is only when nervous current passes over nerve cells in the cortex of the brain that it arouses consciousness (comparable to light in the analogy).

Summary

We have now traced in a rough way how a stimulus such as "a pin stuck into the arm" is connected with three separate responses, "jerking the arm away," "focusing the eye on the hurt spot," and "rubbing the spot with the other hand."

The elements involved are (1) sense-organs (the mechanisms which receive stimulations), (2) muscles (the mechanisms by which responses are made), and (3) nerve-cells which connect the two together.

Nerve-cells (or neurones, as they are more often termed) may be classified as (1) sensory neurones (which connect a sense-organ to the spinal cord or mid-brain), (2) motor neurones (which connect the spinal cord or mid-brain to a muscle), and (3) connecting neurones (which connect all parts of the spinal cord, mid-brain and brain together).

Depending on the point of connection between the current flowing in from the sense-organ and flowing out toward the muscle we speak of (1) the spinal level, (2) the intermediate, or mid-brain, level, or (3) the cortical (cortex of the brain) level.

Let us keep constantly in mind this whole process as depicted in Plate XLII and the above paragraphs so that as we proceed to study the separate parts we may come to understand them more and more thoroughly and to link them up with the whole process.

LESSON 52

MECHANISM BY WHICH STIMULI STIMULATES ONE

Stimuli can effect us only by means of sense-organs. It is impossible to imagine a stimulus which has neither feeling, warmth, cold, nor painful quality, and cannot be seen, heard, smelt or tasted. A wireless message going through the air is such a phenomenon but it is not a stimulus as it does not affect us at all. The wireless operator is affected of course, by his receiving instrument, an apparatus which transforms the unseen and unheard vibrations into a series of clicks which reach his ear.

Popularly speaking we have five senses—sight, hearing, taste, smell, and touch. Actually we have many more than these, as we shall see. Through these sense-organs we receive all our information of the outside world. The purpose of this section is to make clear the process by which situations stimulate us.

(During this laboratory hour, read over the discussion which precedes each set of instructions and then perform the experiments. Be sure you understand the point of each before passing to the next. If you do not finish during the laboratory hour, you can do the remainder at home as no particular apparatus is necessary.)

Cutaneous Sensations

Touch is not a simple sensation but is made up of four kinds of sensations—touch, pain, warmth, and cold. The word *sensation* refers to the simplest sort of conscious response which is possible as the result of a sense-organ being stimulated. As one explores his skin with the point of a knife-blade or toothpick he is conscious of touch, of pain, and of cold. If the knife-blade were warmed slightly, he would also from time to time be conscious of warmth. And after he had marked the spots on the skin with different colored inks where these different sensations were obtained, he would realize that warmth, or cold, or touch, or even pain can only be obtained when certain points on the skin are touched. At first thought it is rather startling to

think that one's skin can be touched in certain places and one will not be conscious of it. But this is true. Evidently there are four different kinds of spots; each arousing a different sensation, and besides there are places in between where no sensation is aroused as a result of slight pressure on the skin.

Problem.—What are some of the characteristics of cutaneous sensations?

Apparatus.—A tooth-pick, pin, two large nails; black, red, green, and purple ink.

Procedure.—(1) Mark off with black ink a ½-inch square, on the under surface of S's arm 2–3 of the way from the wrist to the elbow. Remove all hairs. Now explore this area with a toothpick touching the skin very gently so that the skin just gives under the pressure of the toothpick and record each point at which S (who is blindfolded) reports he feels the toothpick. Do not drag the toothpick over the skin. Record the points by making a tiny black ink spot on the skin wherever you find a touch spot.

2. Re-explore the area using a pin to discover pain-spots. The pressure of the pin should be only slightly greater than with the toothpick. S should now report not touch-spots but only those spots where slight pain is felt. Record these spots by making a tiny red spot on the skin.

3. Explore this area in the same way for cold spots. The point of a lead pencil or of any piece of metal, as a nail, will serve very well for this purpose. In this case the point may be dragged along the skin. Use green ink to record your cold spots.

4. Explore this area in the same way for warm spots. Use a warmed nail furnished by the instructor for exploring the skin. Use purple ink to record your warm spots. (A nail protruding slightly from the cork of a bottle containing hot water does very well for this purpose. The bottles can be kept immersed in hot water until needed.)

Results.—Satisfy yourself that you have the correct answers to the following questions:

1. Do you get different sensations when you stimulate the skin with a toothpick, a pin, a cold nail and a warm nail?

2. Are there distinct points on the skin which always give the same response, if they give any at all, or can you get different responses from the same point on the skin?

3. Will the toothpick arouse any other sensation than touch; the pin, than pain; the nail, than cold; the warmed nail, than warmth?

4. Which of the four kinds of spots are most numerous; which least numerous?

5. Is it possible to touch the skin with a toothpick and obtain no response? Are there points on the skin where the pin can be applied to the skin and not give pain sensation? How about the application of cold and warm nails?

6. What relationship exists between touch-spots and the position of hairs on the arm?

Kinæsthetic Sensations

Kinæsthetic sensations are very similar to touch and pain sensations from the skin. They are to be distinguished from the latter in that the cutaneous sense-organs are located very near the surface of the skin, whereas the kinæsthetic sense-organs are located within the muscles of the body and about the tendons which connect the muscles with the skeleton. These kinæsthetic sense-organs are somewhat similar in structure to the touch sense-organs of the skin. They are obviously not aroused by external objects striking them as are cutaneous sense-organs, but they are stimulated by the changes in pressure of the surrounding tissue upon them. When the arm is doubled up certain muscles have contracted to accomplish this motion, certain other muscles have at the same time relaxed. Consequently the kinæsthetic sense-organs located in the first set of muscles have been more or less squeezed while the sense-organs in the second set of muscles have not been pressed upon as usual. At the same time the sense-organs about the tendons have been stimulated in a corresponding manner. These changes in stimulation are reported to the brain and through experience are interpreted to mean that the arm is doubled up.

All of our information, as to where our arms and legs and fingers are, is reported to the brain in this way, barring, of course, such additional information on this subject as is reported through the eye or skin. "Movements of the body," "weight," and "resistance to movement" are very complex sensations due to the brain receiving stimulations of varying intensities from thousands of sense-organs scattered through the muscles and about the tendons. It is then through kinæsthetic sensations that we get

our basic notion of such physical terms as, "motion," "energy" and "mass."

Problem.—What are some of the characteristics of kinæsthetic sensations?

Apparatus.—Simple objects at hand.

Procedure.—1. Endeavor to lift the table by placing one after another of the four fingers under the edge of the table and lifting up. Determine where the sense-organs are located which are affected by this upward pressure, and which give you some appreciation of the weight of the table.

2. Shut your eyes and turn the head slowly about from right to left. Determine where you obtain part at least of the stimulations which tell you the position of your head at each moment.

3. Shut your eyes and rest your arm on the table in as relaxed a position as possible. Let your partner move your fingers about while you determine as well as you can how you know where each finger is. Cutaneous stimulations are, of course, present, so include them in your discussion. But determine what else is present.

4. Shut your eyes and extend your arms before you palms up. Let your partner place two books or similar objects upon your hands. Determine how you distinguish which is heavier.

5. Extend your left arm before you while blindfolded. Then touch a point on the left hand with your right forefinger as designated by your partner. Determine how you know where your left hand is and how you guide the right hand to it.

6. Write your name as usual; then with your eyes closed. To what extent is the writing of your name determined by (a) cutaneous and kinæsthetic sensations and (b) visual sensations?

7. Close your eyes; have your partner hold your hand and so move it about that you write some short phrase. Can you tell what was written by your own hand? In what respect is this situation different from that of ordinary writing?

Assignment for Next Class-hour

Read over the remainder of this section and then write out the answers to the above questions.

Cutaneous Sense-organs

From physiology we learn that located just beneath the skin there are a number of different kinds of nerve-endings. We do

not yet know all that we should like to about these nerve-endings but it does appear with a fair degree of certainty that there is a different one for each of the four sensations of touch, pain, warmth, and cold. And, moreover, a nerve-ending which gives us the sensation of cold never gives us any other sensation but cold. The same applies to the other nerve-endings. *Each sense-organ gives us a characteristic sensation and never any other sensation but this characteristic one.* This fact is important and should be especially noted. But, on the other hand, *many different kinds of stimulations can produce the same sensation.* A cold spot for example will produce a sensation of cold: (1) when a cold object touches it, (2) when a hot object touches it (but not when a warm object touches it), (3) when an object presses on it (pressure), (4) when it receives a slight electric shock, or (5) when certain chemicals, as menthol, stimulate it. In the same way a pain spot is aroused and gives us the sensation of pain when: (1) it is lightly touched, (2) it is affected by extreme cold, (3) it is affected by heat (4) it is pressed upon, and (5) it is stimulated by electricity.

These sense-spots are distributed unevenly over the surface of the body, being more frequent on the palms of the hands and on the lips than other places and being very infrequent on the back. The total number of the various sense-organs also varies exceedingly. They appear in the approximate ratio of 1 warm spot, 10 cold spots, 10 touch spots, and 40 pain spots. There are certain portions of the body which are lacking in one or more of these sense-organs. The cornea of the eye lacks warm spots and parts of the cornea lack also cold spots. It has pain spots but no touch spots. A portion of the inner membrane of the cheek is sensitive to touch but not to pain.

Simple and Compound Sensations

Besides these four elemental sensations there are various compound sensations, such as: Heat, burning sensation, hardness, softness, wetness, dryness, sharpness, smoothness, roughness, itching, tickling, creepy sensations, blushing, etc. All of these are made up of certain combinations of the four elemental sensations or of smaller sensations located in the muscles. For example: heat is a fusion of warmth and cold; burning sensation of warmth and pain; itching is mainly composed of pain sensations;

as is tickling of touch sensations. The latter can be aroused by brushing the hairs of the skin. (At the base of each hair is located a touch-spot.) Creepy sensations are a complex, probably, of pain and cold.

Nature's "thermometer" illustrates this matter of compound sensations very nicely. We do not naturally think in terms of degrees of heat, but rather in terms of pain, burning hot, hot, lukewarm, no particular temperature, cool, cold, biting cold. These various compounds are due to different degrees (intensity) of stimulation of certain sense-organs and to the various combinations of sense-organs which are stimulated. Temperatures of about 86° Fahrenheit (82° to 93° according to the temperature to which the body has been adjusted) arouse no sensations of temperature. Increasing the temperature from 86° we first have the warm spots stimulated, with the resulting sensation (response) of lukewarmness. The higher the temperature the more the warm spots are stimulated, and the greater is the sensation of warmth. At 113° cold spots are also stimulated and the resulting fusion of warm and cold sensations is heat. Above 122° we have in addition to the stimulations of warm and cold sense-organs stimulation of pain sense-organs. The fusion of all three gives us the sensation of burning heat. In much the same way as we progress from 86° downward in temperature we get cool sensations; and these cool sensations are due to cold spots being more and more stimulated until 54° is reached. At this point pain sense-organs are stimulated. The fusion of cold and pain sense-organs give us biting cold and finally pain. Thus our terms, "biting cold," "heat," and "burning hot," though apparently as simple as "cold," and "warm," are nevertheless fusions or compounds of these two simpler sensations together with "pain."

Simple Sensations are Not Learned.—As soon as the entire nervous mechanism is in working order after birth, a stimulation of any of these four sense-organs will produce its characteristic sensation. In other words, we do not need to learn that a stimulation of a cold spot has the sensation (response) cold. We are born with a bond connecting such a situation with its response. Such sensations are comparable to reflexes.

Compound Sensations are Learned.—We do need to learn, however, that acute touch occurring over an extremely narrow

surface means sharpness (as with a razor-blade) or that when the finger is moved with no jars and only touch-sensations result that that means smoothness. The compound sensations are learned while the simple sensations are not, i. e., are innate. During the early months of life a baby is engaged very largely in learning what various combinations of touch, visual, auditory, etc., sensations mean, i. e., what objects arouse these combinations, or to put it the other way round, what objects really are, as explained in terms of the unlearned responses (simple sensations) which he has at his disposal. Review in this connection the description of the process by which a baby's perception of a rattle develops, as given in Lesson 45.

In the early months of life we learn through trial and error that a rattle requires so much effort to pick up and that the fingers will close about it in a certain way. A doll, on the other hand, will require more effort and the hand will close about it in a different way. With his eyes shut a year-old baby will know a rattle from a doll which his hand touches, in terms of differences in the number, location, and intensity of the kinaesthetic sense-organs which are stimulated and also in the number, location and intensity of the cutaneous sense-organs which are stimulated. It is difficult for an adult to appreciate that these fusions must be learned because they are developed early in life and become so automatic as seldom to arouse our interest in them as such. We gain a little notion of action when we attempt to become experts in distinguishing textiles by feeling, or in estimating weights as to whether a letter needs more than two cents postage, etc.

In the case of judging textiles we develop certain concepts which we use in the work, such concepts being the integration of certain groups of sensations. An expert in textiles will tell you when you inquire as to how he knows one material from another that it is by the "look and feel." Through practice he has built up certain combinations of touch and visual and even auditory sensations which mean a certain material. If you press an expert as to how he makes these judgments he usually cannot tell. He is not aware of the separate sensations which make up the total combination. A few experts can give somewhat of an explanation. Mrs. Blanche E. Hyde says that she tells wool by its "bite" and silk by its "scroop." The sheep's

hair from which wool is made is not a smooth hair but has little sharp points which catch on the skin when handled, as any one knows who has worn a flannel shirt. This is for Mrs. Hyde one of the sensations which makes up the total "look and feel" of wool. But it is clear that it is only one, since she is able to detect wool as it appears in many combinations with other materials and manufactured in many ways. The "scroop" of silk is apparently a combination of a certain touch with a peculiar rustling noise occasioned when two pieces of the silk are rubbed together between the thumb and finger. But to the writer other materials which are not silk seemingly give forth a "scroop" when rubbed,—materials which are instantly named by Mrs. Hyde.

The "feel," as we say, for location of keys on a typewriter or piano, or of position on a violin, is no more than a realization of particular combinations of cutaneous and kinæsthetic sensations. We don't know the individual sensations that make up the compound but we do know the compound itself, as is shown by the quickness with which we notice a false move.

All of our motor habits are developed principally in terms of kinæsthetic sensations, although sensations from other sense-organs play a more or less important part. In lacing one's shoes, the first movement arouses a great number of kinæsthetic, cutaneous and visual sensations. This compound then makes up the situation which starts the next movement going. The second movement in turn arouses a new set of kinæsthetic, cutaneous and visual sensations. They in turn form the situation which initiates the third movement, etc. Just what part the visual sensations play in handwriting as distinguished from the kinæsthetic can be readily seen by writing with the eyes open and then with them shut. As there is no way of shutting off the kinæsthetic sensations except by cutting the nerves connecting the kinæsthetic sense-organs with the brain we cannot tell how well we could write if we had only visual sensations to guide us. From certain types of nervous disorders, however, it is clear that we would be fearfully handicapped by such a loss and that our best efforts would fall far short of what we now do. Possibly the best way to realize this is to have some one hold your hand at the blackboard while you are blindfolded and guide your hand so as to write various sentences. Here a new set of kinæsthetic sensations are aroused and it is surprising how difficult it is to judge what one's own hand has written.

Skill in the use of tools is pretty largely a matter of developing groups of compound sensations composed of cutaneous, kinæsthetic, visual and often auditory sensations. As ordinarily we are not aware of the elements, learning to use a plane, for example, has to be a matter of trial and error learning. The more, however, our instructor explains the plane and corrects our faulty moves, the more are we made conscious of the details involved in the whole process and of the necessary sequence, and the quicker we learn.

What is a "Situation?"

In Lesson 3 the distinction between situation and stimulus was pointed out. The term situation was defined as the sum total of all factors affecting an individual at one moment to which he responds. This "sum total" was recognized to include two distinct factors:—first, factors external to the nervous system which stimulate one or more sense-organs; and second, factors within the nervous system, such as habits of responding in a certain way, emotions, desires, and the like. The first group of factors are, strictly speaking, stimuli.

A stimulus is something that stimulates a sense-organ. This always implies, of course, the presence of a sense-organ to be stimulated and the presence of a sensory nerve which transmits the stimulation from the sense-organ to the central nervous system. For one would not jerk his hand off a hot stove if (1) the hot stove were not there, (2) the sense-organs of the skin were anæsthetized, or (3) the nerve were cut. As far as behavior is concerned the stmulus is not an external object but the kind of nervous stimulation which reaches the central nervous system.

The total situation to which one responds is accordingly dependent upon the incoming nervous stimulations and the various systems of nerve cells which are active at the time, all of these determining the pathway over which the stimulations will travel to the muscles that respond; and that pathway, as we have seen, is controlled by previous learning and the "wants" present at the moment which "select" from all the incoming stimulations those to which a response will be made. (The wants again are expressions, not simply of innate instincts, but the modifications of these innate wants that have been built up from experience.)

LESSON 53

THE EYE: A MECHANISM BY WHICH STIMULI STIMULATES ONE

In the case of the cutaneous and kinæsthetic sense-organs the structure of the sense-organ is relatively simple. There the stimulus affects the nerve ending in a direct manner. The eye, on the other hand, is an elaborate mechanism.

In order to understand this mechanism it is necessary first of all to obtain some idea of the structure of the sense-organ itself and also the physical nature of the stimulus.

Structure of the Eye

The eye can be best understood if it is compared to a camera. The three parts essential to a camera are the box, the lens, and the film. Let us consider the structure of the eye with these three divisions before us.

The Gross Structure of the Eye (The Box).—"The eye has a tough, thick outer coat, the *sclerotic,* to which are attached the muscles that move it" about in its socket. "Inside the sclerotic is another membrane, the *choroid,* which contains blood vessels and is provided with a dense dark pigment that renders the inside of the eye essentially impervious to all light, save that which comes through the opening in the *iris.*" Inside the choroid is the third layer, the *retina,* which is our "film." Note the relationship of these parts in Plate XLIII.

The Lens System is made up of two parts—the cornea and the crystalline lens. The *cornea* is really only a part of the sclerotic coat. But the structure of the tissue is changed somewhat from the remainder of the sclerotic layer—being transparent instead of being white and opaque. The lens lies just behind the iris, the colored portion of the eye. It is attached to the choroid coat by a ligament, which is in turn attached to the *ciliary muscle.* Between the cornea and the lens we have a small chamber filled with a liquid much like water (aqueous humour). Back of the

lens we have another chamber, occupying the interior of the eye. This chamber is filled with a jelly-like substance (called the vitreous humour).

The Retina (The Film).—As already pointed out, the retina is the inner membrane of the eye. It is really a part of the brain, being composed of nerve-cells which in the course of development have come to the surface. It is made up essentially of three layers of these nerve-cells, the inner layer being composed of what are known as *rods* and *cones*. (According to Kölliker the cones in the fovea are from 0.0045 mm. to 0.0055 mm. in diameter, i. e., 0.000177 inches to 0.0002165 inches. This gives some idea of their minuteness.[1])

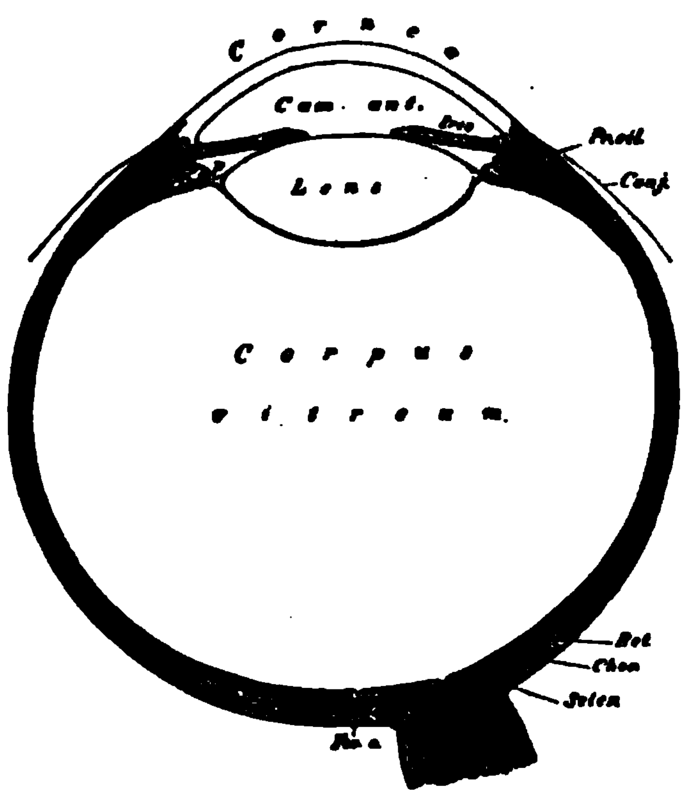


Plate XLIII.—Opt., optic nerve; Fov. c., fovea centralis; Scler., sclerotic; Chor., choroid; Ret., retina; Conj., conjunctiva; Pr. cil., ciliary processes by means of which lens is adjusted; Cam. ant., anterior chamber filled with aqueous humour; p. posterior chamber. Just below "p" the capsule and ligament supporting the lens are shown attached to the ciliary processes. Corpus vitreum, the vitreous humour of the main cavity of the eyeball. (From J. R. Angell, *Psychology*, 1909, Figure 47, published by Henry Holt and Company.)

Directly opposite the iris and the center of the lens is the *fovea*. This is a point in the retina where there are only cones. It is the point of clearest vision—the part of the eye which receives the greatest number of stimulations. This is true, since whenever we are looking directly at an object the head and eyes have been so turned that the light waves fall upon this spot. Leading back from the nerve-cells in the retina are nerve-fibers which unite and form the optic nerve which proceeds first to the mid-

[1] G. T. Ladd and R. S. Woodworth, *Physiological Psychology*, 1911, p. 316.

brain and then on to the cerebrum. The rods and cones have apparently different functions. Color is perceived because of the stimulation of the cones, while light and darkness are perceived because of the rods. Especially is this function of the rods true as regards vision in dim light. Color blindness is due to an affection of the cones, while faulty vision in dim light is due to that of the rods.

The Nature of the Light Stimulus

In both visual and auditory sensations we must distinguish three different stages in the sensory excitation. There are first, the physical stimulus, second, a physiological change in the sense-organ, and third, the resulting conscious quality.

The visual physical stimulus is due, so physics teaches us, to vibration in the ether, whereas the auditory physical stimulus is due to vibration in the air. Such vibrations may vary in three ways: in the rate of vibration, in the amplitude of the vibration, or in the form of the wave.[1]

1. Changes in the rate of vibration. The ether may vibrate more slowly or more rapidly. When it vibrates at the rate of 390,000,000,000,000 per second we become conscious of the color red. When it vibrates at twice this rate (i. e., 757,000,000,000,000 per second) we become conscious of violet. The other colors fall in between these two extremes. Beyond these two extremes are other vibration rates which are known to physics but which do not stimulate the retina. Ultraviolet rays do not affect the human camera but they do affect the film of a kodak. Other such rays invisible to man are the X-rays, and the rays by which wireless messages are sent. Changes in the rate of vibration

[1] Those unfamiliar with these terms will do well to experiment with a guy-wire supporting a telephone pole, which is attached at the top of the pole and to an anchor in the ground. Or a stout string tautly stretched from one end of the room to the other will serve the purpose. Strike the wire with a stick or the string with a pencil and note the wave that runs along it. The wire itself does not move forward but it so vibrates that a wave does travel and if one will take hold of the far end of the wire or string he will note that considerable force is exerted by the wire against its end support. In these examples the rate of vibration depends upon the material, length, etc., of the wire. The amplitude (size of the wave) depends upon how hard it is hit. The form of the wave depends upon whether it is hit once or twice in very quick succession, etc.

within certain limits are responsible for the particular colors that are consciously seen.

2. Changes in the amplitude of the vibration result in differences in the intensity of the colors, i. e., in the brightness of the colors. Amplitude refers to the amount of back and forth swing to the vibration. If one strikes a tuning fork it gives forth a loud tone at the start when the prongs are swinging back and forth vigorously and as this movement dies down the tone becomes weaker and weaker. Here there is a change in the amplitude as the vibration dies down but no change in the rate of vibration. Suppose in the case of light we have 390,000,000,000,000 vibrations per second striking the retina, giving us the sensation red. Now if the amplitude was practically zero, i. e., there was practically no back and forth swing, this red would appear practically black. As the amplitude was increased one would have successively, brown, dark red, red, bright red, pink, and with a very great amplitude, white. Changes in the amplitude, then, determine the amount of white or gray or black that is seen either alone or in combination with a color.

3. Changes in the form of the wave. The ether may be vibrating so as to produce pure red or pure blue or it may be vibrating so as to produce red and blue at the same moment. In this case we are not conscious of red and blue separately but of the color purple instead. White light from the sun is a case where the ether is vibrating to give us all the colors simultaneously. With the use of a prism these various vibrations can be separated and then we get all of the colors instead of their blending, which appears to us as white.

Change from the Physical Stimulus to Physiological Process.—The physical stimulus—the vibrating ether—having traveled from the object outside to the retina affects the rods and cones in some way still unknown. A number of theories have been advanced but no one has been accepted by all. All that we do know is that here a radical change takes place in the form of the light stimulus, for the ether vibrations now set up certain physiological or chemical changes in the rods and cones. This chemical action is then transmitted along the nerve fibers to the mid-brain and then on to the cortex of the brain. Possibly the best analogy to explain the transmission of this chemical change is to picture a train of gunpowder along a sidewalk. When a burning

match is applied at one end the combustion is almost instantaneously transmitted to the other end. Combustion is, of course, a simple chemical change, so that the spread of the fire is an instance of spread of chemical change. Recent experiments prove that CO_2 is given off by nerve-fibers when engaged in transmitting stimulations, indicating the presence of chemical changes in the fibre. Then, too, the fact that the nervous impulse travels comparatively slowly, i. e., 100 feet per second, suggests a chemical process. This is very slow as compared with the speed of sound which is 1,100 feet per second, or of light which is 186,000 miles per second. Electricity in a good conductor will go about as fast as light. Evidently then the stimulus does not remain physical throughout but is changed into a physiological one when the light waves strike the retina. And from here the stimulus is conveyed over several nerve-cells to the optic nerve and over this pathway to the mid-brain and from there finally to the cortex of the brain.

The Change from Physiological Process to Conscious Quality. In the cortex of the brain this stimulus which has traversed the optic nerve gives rise to the conscious qualities of brightness (black-gray-white) and color with which we are all familiar. But here again we know nothing as to how the nervous changes in the nerve-cells produce the qualities of which we are conscious.

How We See the North Star.—Because of the molten state of the North Star it causes the ether to be set into vibration. This vibration-wave is very complex so that when its light-wave is broken up by passing it through a prism we can obtain many different colors. Although light travels at the incredible rate of 186,000 miles per second, astronomers figure it takes 44.0 years for the vibration to reach the eye. It passes through the cornea, the aqueous humour, the lens, the vitreous humour, and the two outer layers of the retina and finally reaches the rods and cones. Here it arouses a physiological process (through chemical changes, possibly somewhat similar to the change produced in a kodak film). This process is transmitted to the brain and there interpreted in terms of a spot of light in the dark sky.

Convergence, Divergence and Accommodation

By means of six muscles attached to each eye, the eye balls may be turned in their sockets so that the rays of light from an object,

at which we are looking, may fall upon the fovea. When the two eyes are made to turn inward toward a nearby object the process is called *convergence*. When they are turned outward toward a distant object it is called *divergence*. Within and about these six muscles are many kinæsthetic sense-organs. When the muscles relax or contract these sense-organs are stimulated. These kinæsthetic stimulations are scarcely ever noticed in a conscious way. Nevertheless, estimation of distance is based to a very considerable extent upon them.

Through the processes of convergence and divergence the two eyes are adjusted so as to be both turned toward the same point. But this is not sufficient to secure clear vision. In a camera we must regulate the distance of the lens from the film according as the object to be photographed is near or far away. In the human eye this adjustment is made not by moving the lens but by changing its shape. This process is called *accommodation*. The ciliary muscle controls the lens causing it to become more or less convex, thus affecting the convergence of the rays of light upon the fovea. In monocular vision differences in distance up to a few feet can be estimated fairly accurately in terms of the kinæsthetic sensations arising from the ciliary muscle. These estimations are, however, unconsciously made.

Defective Vision

Myopia and Hyperopia.—In the normal eye the distance from the cornea to the fovea is 20 millimeters (¾ of an inch). If now the eye is so constructed that this distance is greater than 20 mm. the image of distant objects is formed in front of the retina and only near objects can be clearly seen (near-sightedness or myopia). On the other hand, if this distance is less than 20 mm. then the image of objects will be formed behind the retina and the refractive power of the eye must be increased to permit of clear vision (long-sightedness or hyperopia). "The hyperopic eye must consequently exert an effort of accommodation in order clearly to see objects at a distance, while for near work this effort must be excessive. The result is that the hyperopic eye is under constant and abnormal strain from the incessant demands upon its ciliary muscle, and that, in consequence, numerous secondary symptoms or resultant effects appear, some of them obvious, others unexpected, many of them serious. Local symptoms

appear in inflammation, redness, or soreness of the eyes, lids or conjunctiva, and in twitchings and pain within the eye ball. Aside from these local disturbances, perhaps the most constant symptom of hyperopia is frontal or occipital headache."[1]

Both myopia and hyperopia may be counteracted by the use of glasses.

Astigmatism.—"In a perfectly normal or ideal eye the refractive surfaces, cornea, anterior and posterior surfaces of the lens, are sections of true spheres, and, all the meridians being of equal curvature the refraction along these different meridians is equal. Such an eye will bring the cone of rays proceeding from a luminous point to a focal point on the retina, barring the disturbing influence of chromatic and spherical aberration. If, however, one or all of the refractive surfaces have unequal curvatures along different meridians, then it is obvious that the rays from a luminous point cannot be brought to a focal point, since the rays along the meridian of greater curvature will be brought to a focus first and begin to diverge before the rays along the lesser curvature are focused. Such a condition is designated as astigmatism."[2]

In a person afflicted with astigmatism there must be a ceaseless activity of the ciliary muscle as first one point and then another of a scene is focused. In normal vision many of such points can be focused at the same time thereby requiring less effort of this muscle and also providing fuller and richer vision. Astigmatism can ordinarily be corrected by wearing properly fitted glasses.

Color-blindness.—About 4% of men and less than 0.5% of women are color-blind. Most of these are red-green blind which means that they do not see any difference between these two colors. "Total color-blindness, while well-authenticated, is rare, and is presumably a pathological defect." "It is obvious that many callings are, or should be, closed to the color-blind, e. g., railroading, marine and naval service, medicine, chemical analysis, painting and decorating, certain branches of botany, microscopy, mineralogy, the handling of dry goods, millinery, etc. In some phases of school work, the color-blind pupil is likewise at an evident disadvantage. The color-blind test should,

[1] G. M., Whipple, *Manual of Mental and Physical Tests*, 2nd edition, 1914, p. 164.

[2] W. H. Howell, *A Text-Book of Physiology*, 1907, p. 302.

accordingly, be regularly instituted in the early years of school life, in order that the existence of the defect may be made known to the child as soon as possible."[1]

Fusion of Visual and Tactual Sensations

Stratton carried on some experiments a number of years ago, as follows. He wore constantly for a week a pair of glasses with two lenses so constructed that every object appeared upside down. "The results showed that an experience coming from such an image would in time be indistinguishable from our normal experience. The first effect was to make things, as seen, appear to be in a totally different place from that in which they were felt. But this discord between visual and tactual positions tended gradually to disappear; not that the visual scene finally turned to the position it had before the inversion, but rather the tactual feeling of things tended to swing into line with the altered sight of them. The observer came more and more to refer his touch impressions to the place where he saw the object to be; so that it was clearly a mere matter of time when a complete agreement of touch and sight would be secured under these unusual conditions." As Stratton points out "harmony of touch and sight can grow up under the greatest variety of circumstances, provided merely that the experience remains uniform long enough to develop fixed expectation."[2]

Summary

The eye is a mechanism for adjusting physical light vibrations so that they will arouse physiological changes in the retina, which, in turn, will be conveyed to the brain and interpreted in terms of our past experiences. A visual situation must be thought of, not in terms of the object itself, but in terms of the nervous processes which are aroused by it.

Organic, Gustatory, Olfactory, Auditory and Static Sensations

In addition to cutaneous, kinæsthetic and visual sensations, we have several others. Organic sense-organs are similar to

[1] G. M. Whipple, *op. cit.*, p. 189.

[2] G. M. Stratton, *Experimental Psychology and Culture*, 1903, p. 146–149.

cutaneous and kinæsthetic, but are located not in the skin or about the muscles, but in and about the internal organs. From these sense-organs we obtain the little information that we do receive as to the working of these organs. They arouse such sensations as thirst; hunger; nausea; heartburn; suffocation; pain of a general, massive, agony type; and general bodily feelings of well or ill. Gustatory sense-organs are located in the mouth, and olfactory in the upper portion of the nasal cavity. Sensations of taste and odor are too familiar to need discussion here.

Organic, gustatory and olfactory sensations are similar to cutaneous and kinæsthetic. A specific stimulus affects a very simple sense-organ consisting apparently of not much more than a nerve ending and we obtain the sensation characteristic of that sense-organ.

Auditory situations, on the other hand, are received and affect consciousness by means of an elaborate receiving mechanism similar to the eye in complexity. It is not essential that the anatomy of the ear be mastered. It is sufficient that one realizes that a physical stimulation—vibration of the air—is converted within the ear into a physiological stimulation which is transmitted over the auditory nerve to the brain and that there the air vibration is expressed in consciousness in the form of different tones and noises and their combinations.

Still another type of situation which affects us is known as the "static." We are not directly conscious of it, but only indirectly through its influence upon other sense-organs, particularly the organic sense-organs. Within the semi-circular canals of the ear and two adjacent small bodies are little hairs projecting into the liquid filling these organs. Whenever the head is moved, the liquid is disturbed, just as water in a glass is disturbed if the glass is moved. The liquid in turn disturbs the hairs, which in turn excite the nerves connected with them. These stimulations are transmitted to the mid-brain and from thence to various sense-centers which control the movements of the body. Here is the mechanism, for example, which starts the movement to regain our equilibrium when we slip on a banana peel. Excessive stimulation of these static sense-organs, as in swinging in a swing, whirling around, being tossed about in a ship, etc., brings about changes in the bodily organs. These changes in turn affect the organic sense-organs therein situated and we feel dizzy, or seasick.

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LESSON 54

HOW DOES ONE ESTIMATE DISTANCE?

Space-perception

We have seen in Lesson 52 that there are four cutaneous sensations which are simple experiences and cannot be resolved into any simpler sort of consciousness. We have also seen that there are a great many other so-called sensations which appear at first thought to be equally simple, such as hardness, softness, dryness, smoothness, etc. But, on closer study, these can all be resolved into simpler sensations. These so-called sensations have been referred to as compound sensations. Compound sensations have been developed through experience—have been learned. Another term of somewhat similar meaning is "percept." When we use the expression "compound sensation" we have reference primarily to the abstract quality, say of sharpness; when "percept" is employed we are thinking of the particular object which is sharp. Actually, it is very improbable if we ever experience "sharpness" as a compound sensation in this sense. Rather, we always think not only of sharpness but also of the object which occasions the sharpness. That is, the combination of elementary sensations gives us directly the perception of a *sharp object.*

Apparently the estimation of any distance is a perception, due to the combination of certain sensations experienced together and from experience known as "this object" "so far from us." Now we want to discover in this lesson and in Lesson 56 some of the factors in terms of which we perceive that a certain object is nearer than a second object and farther away than a third object. For example, how do you know that the tree you see is outside the window instead of inside? How do you know this telephone pole is nearer than that one?

This problem is assigned not only because it is worth while in itself, but because it will illustrate to some extent how we have built up through experience such notions as distance, time, space, height, weight, etc. In fact, the fundamental principles of how

we have learned to estimate distance underlie the development of all our perceptions of objects, as a cow, horse, barn, book, etc. (Review Lesson 45).

This problem is also assigned because it illustrates the analysis teachers must make of the processes they are to teach. The more detailed a grasp of the separate processes involved in using a plane, or saw, or pen, or typewriter he has, the better can the teacher teach their use. For when the complex whole has been analyzed into its component parts, then the teacher can call the student's attention to the parts and aid him in mastering each part and performing them in their proper sequence. Otherwise the learning must be entirely a "trial and error" performance—the most tedious way of learning.

Estimation of Distance

The problem before us primarily is the determination of the distance of one object with reference to other objects, i. e., is it nearer or farther away than the other objects? The conversion of this idea of relative distance into measurements of distance, is another matter and will not concern us in this experiment.

If we close one eye and move our finger back and forth toward the nose and then away from it, it is clear that we can determine its position with regard to our nose very well. How we do this with one eye (monocular vision) is one problem.

If we look with both eyes at near objects and then objects farther away (but less than 100 feet), it is again clear that we can determine their relative position very well. How we do this with both eyes (binocular vision) is a second problem.

And if we look at distant objects through the window, it is also clear that we can determine their relative distance, although possibly not so well. How we do this is a third problem.

The second problem of binocular vision under 100 feet distance will be attacked in this lesson; the first and third problems in Lesson 56.

Experiment

Problem.—What are the factors underlying the perception of distance of objects within 100 feet with binocular vision?

Apparatus.—A number of small objects; a stereoscope and views of the Titchener Series.

Procedure.—(1) Select some narrow object (A), e. g., the string attached to the curtain in the window, or the wooden strip between two panes of glass in the window, or a drop cord supporting an electric light. Seat yourself so that you can look past the object to some other object (B) some distance away. Now alternately focus on A and B fifteen to twenty times. Note that A appears first as one string and then as two strings. Note the change in the strain felt in the eyes. And note also changes in the position of your partner's eyeballs when he is thus focusing back and forth.

2. Select two books (C and D). Stand book C on end upon the table with its side about three feet away (placed at three feet to exaggerate the phenomenon). Stand book D a few inches nearer and with its *back* towards you. Book D now stands more or less perpendicular to book C. Now note the difference in the details which can be seen of book D as you look at it alternately with the right eye and the left eye. Also observe the differences which can be seen in book C under the two conditions—book C acting as a background for the view of book D. (If you do not discover such differences in book C, move your position slightly. Be very careful not to move the head from side to side as you look alternately with one eye and the other.) Note the following points: (a) The two views are different; (b) the points on the back of the book D are displaced more from right to left than the points of book C; (c) the view seen by the two eyes together is a fusion of what both eyes see—not an average of what the two see—and you are not conscious of whether you see a detail with one eye or with the other (until you have experimented).

Confirm these points and add any others that are discovered through studying these and other objects about the room. Draw what is seen with each eye separately when looking at the two books.

3. Carefully note the differences in the details of the two photographs which comprise a stereoscopic picture (use, for example, Nos. 15, 17, 37, etc., of the Titchener series). Choose two points in the picture, one of which is in the very near foreground and the other far back in the background. Measure carefully the distance from these two points to the right hand edge of the picture in which they occur. Note whether a near point varies more to the right and left in the two photographs than a distant point.

4. Note slide No. 1. Here are two views composed of two dots each. In the right hand view, however, the dots are spaced farther apart than in the left hand view. Why, when seen in the stereoscope, does one dot appear nearer than the other? Would this occur if the spacing between the two dots was the same in the two views?

Results.—Carefully compare your findings in the four experiments. What relationship do they bear to one another? Answer the following questions, after reading over the section in Lesson 53 on "Convergence, Divergence and Accommodation:"

1. How do the differences in what is seen by the two eyes of a near object differ from what is seen of a distant object? How do the differences in objects in the foreground of two stereoscopic pictures differ from the differences in objects in the background? Explain.

2. Is there any relationship between the differences in the views of a book as seen by the two eyes and the differences between two stereoscopic pictures? Explain.

3. Is it correct to state that when the two views of an object, as recorded on the retina of the two eyes, differ, then those points which differ most are seen as nearby while those points which differ only a little are seen as far away? Explain your point of view.

Application.—What general relationship is there between the results discovered here and learning in general?

Assignment for Next Class Hour

1. Write up the above experiment.

2. Be prepared to discuss Lesson 53 in class.

3. During the next few days be gathering data on how you are able to determine the relative distance of objects, both of which are more than 100 feet away. Jot down every clue that comes to mind. (The answers to this problem are very simple, so simple that most students overlook them in endeavoring to discover some profound proposition.)

LESSON 55

MECHANISM BY WHICH RESPONSES ARE MADE

In Lesson 51 a bird's-eye view of the whole physiological explanation of behavior was presented. This was expressed under three general headings: Stimulation of a sense-organ (the stimulus), movement of a muscle or muscles (the response), and the connection of sense-organ and muscle (the bond). In Lessons 52 and 53 we have studied typical mechanisms by which stimuli affect one. We have seen that certain kinds of stimulations arouse a sense-organ to activity and that that activity is passed on over nerve pathways to the spinal-cord or brain. We now shall consider how the response is made to these situations.

In order to have before us a proper perspective, consider again the example given in Plate XLI. There is illustrated the simplest possible type of situation and response (reflex action). A pin is stuck into the skin. One or more pain and touch spots are stimulated. A nervous discharge from the sense-organs proceeds over the nervous pathway to the spinal-cord. This current then jumps a gap to another nerve-cell along whose fibre it proceeds until it reaches the muscle C. This muscle then contracts and the arm is pulled away. (Actually, the case is more complex, involving more than one muscle and more than one pathway.) This example illustrates a complete stimulus-response functioning. The problems before us are: just how does a stimulated muscle move a portion of the body, and, second, how does a nervous current stimulate the muscle and cause it to react?

How Does the Contraction of a Muscle Move a Part of the Body?

In Plate XLIV is shown a diagram of the two major muscles of the upper arm and their relation to the bones of the arm, forearm, and shoulder. The biceps ("4" in the diagram) is attached to the shoulder and to the bones of the forearm. In the latter case it is attached a short distance beyond the elbow end of the bone.

The bones of the forearm and upper arm are jointed together somewhat after the fashion of a door-hinge. If the biceps should contract, it is clear that it would pull the shoulder blade and the bones of the forearm. Either the shoulder or the forearm bones would have to move. As the shoulder is fastened, the forearm has to swing up. The forearm acts like a lever here.

A slight pull on it at 6, where the biceps is attached to it, results in a large movement at the finger ends. In compensation for the increase in motion at 12 over that at 7, there is a corresponding loss in power. Contraction of the biceps results, then, in movement of the forearm.

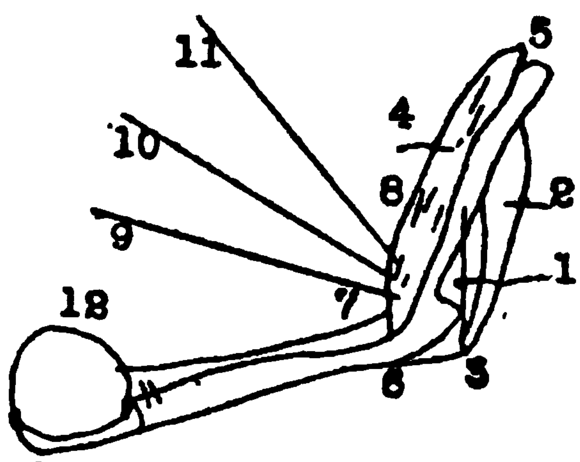

Plate XLIV.—Motor Mechanism. 1. The humerus. 2. The muscle by which the joint is straightened (the triceps). 3. Its insertion. 4. The muscle by which the elbow is bent (the biceps). 5. Its origin. 6. Its insertion. When the muscle 4 contracts by an amount represented by 7 to 8, the amount of motion of the ball will be represented by 9 to 11. There is a loss of power which is compensated by an increase of motion. (D. J. Hill, *The Elements of Psychology*, 1888, p. 401.)

Muscles which have to do with movements of the body are attached to the bones of the body. They are normally in a state of elastic tension. In most cases, they are in pairs, as in the case of the forearm. One pulls the arm up, the other down. The elastic tension is conducive to a smooth and very prompt movement. When the biceps is stimulated so as to contract, the triceps is stimulated so as to relax, and vice versa.

How Does the Nervous Current Stimulate the Muscle and Cause It to React?

Before answering this question, a few facts need to be considered concerning the structure of the muscle. There are two kinds of muscles: (1) Striated skeletal muscle, and (2) plain muscle. Muscles which move the body belong to the first group, while muscles which have to do with the blood vessels, alimen-

tary canal, glands of the body, etc., belong to the second group. We shall consider here only the former group. A skeletal muscle is made up of many fibers composed of a single cell, enclosed in an elastic membrane. When the motor nerve enters the muscle, it subdivides and subdivides until there is at least one nerve fibril attaching itself to each fibre of the muscle. The point of attachment is near the middle of the fibre. This point is called a motor end-plate. Returning to our main question now, we can see that when a nervous stimulation is transmitted from the spinal cord to the muscle it reaches, by way of these motor end plates, every fibre in the muscle. The effect of this stimulation on the muscle is to produce a chemical change (as yet not very well understood) which causes the fibre to contract. Consequently, the whole muscle contracts, and its attached bone is moved.

When a muscle contracts, it gives off heat and electrical energy and produces work. In other words, the chemical change caused by the stimulation of the muscle can be likened to the case of a gas-engine, where heat and work result from the combustion of gasolene. But the human muscle is a very much more efficient engine than a steam or gasolene engine. Only 10 to 15 per cent. of the energy contained in coal is converted into work by a steam engine, 15 to 25 per cent. of the energy in gasolene in the case of a gasolene engine, whereas from 25 to even 40 per cent, is utilized in the case of a muscle. The remainder of the stored-up energy is wasted mainly in the form of heat. In the case of an engine, this is all pure waste, but in the case of the animal, much of this heat is utilized in keeping the organism warm.

Fatigue

The contraction of the muscle is due to chemical changes. As a result of these changes, carbon dioxide gas (CO_2), lactic acid ($C_3H_6O_3$), and acid potassium phosphate (KH_2PO_4) are liberated. Glycogen, the form in which digested sugar is stored in the body, disappears. *Fatigue*, which is due to excessive contractions of muscles, is chemically the loss of glycogen and the abnormal presence of these by-products. As a steam engine will cease to run when the coal is exhausted or when the grates are choked with ashes, so a muscle becomes fatigued when the glycogen is

used up or the muscle is poisoned by the waste products of its combustion.

Whether work is fatiguing or not depends largely upon whether the blood can supply glycogen fast enough to supply the working muscle and at the same time remove the waste products. The faster the muscles are operating, the greater the load upon the heart, lungs and blood, and the quicker fatigue will appear. Recently, experiments have demonstrated that the establishment of short *rest periods* throughout the working hours tends to lessen fatigue and so permit of a greater amount of work being done. The wheelbarrow men, mentioned in Lesson 1, who could do more work by working twelve minutes and resting three minutes in every fifteen minutes, instead of working steadily all day, illustrated this fact. Maggiora[1] has shown that if 30 contractions

PLATE XLV.—Showing fatigue from work. The height of the successive lines shows the amount of work done with each contraction.

exhaust a muscle so that it needs 2 hours rest in order to do equally efficient work again, 15 contractions will require not 1 hour's rest but only ½ hour's rest for recuperation. The second 15 contractions exhaust the muscles, then, very much more than did the first 15 contractions. At the same time the amount of work accomplished by the last 15 contractions is much less (as can be seen from Plate XLV) than that accomplished by the first 15 contractions. Roughly to illustrate this, suppose the 1st contraction does 20 units of work, the 15th contraction 10 units and the 30th contraction 0 units. Then the first 15 contractions would do $(20 + 10) \times 15/2$, i. e., 225 units of work and the last 15 contractions would do $(10 + 0) \times 15/2$, i. e., 75 units of work. Now if A should do 15 contractions and then rest 30 minutes alternately for 8 hours, he could do (16×225), i. e., 3,600 units

[1] Quoted from J. Goldmark, *Fatigue and Efficiency*, 1912, p. 33*f*.

of work, whereas B, who did 30 contractions and then had to stop for 2 hours in order to be rested, could do $(4 \times (225 + 75))$, i. e., 1,200 units of work. A so worked that he never became particularly fatigued and he only worked while he was doing efficient work (i. e., the first 15 contractions). B, on the other hand, kept working until exhausted and then had to rest a long time. By so working he also did inefficient work.

The alternation of work and rest periods secures to the worker his maximum output since his muscles do not become clogged with poisonous waste products and they always are supplied with sufficient glycogen. The proper ratio of work and rest depends on the type of work to be done. Excessively hard work will require relatively more frequent and longer rest periods than more moderate work. In cases of light work, it has been found advantageous to have the workers work at top speed for an interval and then rest, advantageous from the standpoint of work accomplished and interest and lack of fatigue on the part of the worker. Most individuals become more wearied by the monotony of an easy task than by the work itself. Rest periods break up this feeling of ennui, especially when during the working period the work is done at such a rate as to demand one's full attention.

As so-called mental work seldom calls for a steady, rapid use of any set of muscles, the rest-period principle hardly applies to it as it does to hard physical labor. A recess period every hour or two is probably all that is necessary to rest the large muscles which are engaged in surpporting the body while one is reading or writing. Experimental studies of fatigue from mental work show that the amount of fatigue is very small. For example, "Heck[1] gave tests to school children at four periods during the day—between 9 A. M. and 9:30 A. M., between 11 A. M. and 11:30 A. M., shortly after 1 P. M., and about 2:30 P. M. It appears from this experiment that the amount of work done is increased in the later periods, while the accuracy decreased, but there does not appear to be any large decrease in efficiency due to fatigue."[2] Table XII shows typical results from one school.

[1] W. H. Heck, A Study of Mental Fatigue in Relation to the Daily School Program. *Psychological Clinic*, Vol. 7, 1913–14, p. 29ff, 258ff.

[2] Quotations and Table XII from F. N. Freeman, *How Children Learn*, 1917, p. 289.

TABLE XII.—THE PERCENTAGE OF EFFICIENCY OF SCHOOL CHILDREN AT FOUR PERIODS, TAKING THE PERFORMANCE AT THE FIRST PERIOD AS 100 PER CENT.

	Periods			
	9:00 A. M.	11:00 A. M.	1:30 P. M.	2.30 P. M.
Amount done.........	100	100.72	103.63	101.10
Accuracy.............	100	96.69	95.64	96.38

The real problem in the school-room is not fatigue, but ennui, lack of interest. As Thorndike has repeatedly affirmed, children have too little to do rather than too much. They are not supplied with material to keep their minds and bodies busy. Any adult who has attempted to play with children knows how impossible it is to tire them out. They can keep on the jump from morning to night, or build blocks, or paste in a scrap book as assiduously as any adult, when they want to.

Exhaustion.—Fatigue is a perfectly normal process. It may be defined, according to Thorndike, as "that diminution in efficiency which rest will cure."[1] *Exhaustion*, on the other hand, is a loss of efficiency which ordinary rest will not cure. In cases of exhaustion, not only is the glycogen used up, but also part of the muscular structure itself. In consequence, it takes a comparatively long time for one to recover from the effects of exhausting work.

Exhaustion is present in the case of many persons who are forced by circumstances to work harder and for longer hours than they can really stand. Its elimination is an important industrial and social problem. But fear of exhaustion, on the other hand, does still more harm, for it prevents men and women from exerting themselves as they should and robs them of the success they might otherwise achieve. Aside from worry, a most fatiguing performance, very few of those directing their own activities ever exhaust themselves. It is normal to go to bed fatigued. Sufficient sleep should cure fatigue and fit us for another strenuous day.

[1] E. L. Thorndike, *Educational Psychology*, Vol. III, 1914, p. 112.

WHAT IS A RESPONSE?

The term "response" has meant so far all those details of an individual's action which result from some situation affecting him. It is well now to consider the term in greater detail. A response consists of movements of muscles. But the muscles may be those that (a) move parts of the body, as the arm, leg, head, etc., or (b) affect the internal organs, as the heart, the stomach, the various glands, etc. The first type we are all more or less familiar with, since we are continually and consciously making such movements and are observing them in others. The second type we are not conscious of ordinarily. But they play an equally important part in our life. In the quotation in Lesson 1 from "Wednesday Madness," we read "Sam started violently" in response to Penrod's "Sam-my and May-bul." And "Mabel ceased to swing her foot, and both, encarnadined, looked up." The "starting violently" and becoming "encarnadined" are evidences we may note in another of emotional excitement—a term covering movements of the inner organs. And these responses are more significant in this case than "ceasing to swing her foot" and "looking up."

A response may consist, further, in a train of thought, in the formulation of a decision, or in an attitude. The latter we saw clearly in the mirror-drawing experiment, where some assumed a self-attentive attitude and others did not. But such purely "mental" responses are accompanied by muscular movements, although they may at times be very slight or seemingly of no connection with the mental processes. One only has to watch carefully a person who pretends to be contemptuous of one's teasing to discover slight twitchings at the corner of the mouth, or tapping with the foot, etc.—all signs that the teasing is being reacted to.

When one suddenly comes upon a covey of young quail, there is immediately a tremendous fluttering in the brush and then an absolute quiet. The young birds have reacted to the situation of a man's presence by running to cover and then remaining absolutely still. The lack of movement is as much a part of the response as the scurrying to cover. Here is inhibition of movement as a type of response.

In every-day life we are much more likely to overlook responses

to a situation which cause lack of bodily movement than of responses where the individual does something. Sometimes the absence of movement, when ordinarily movement is to be expected, is just the response to be noted. For example, candy having disappeared from a table drawer, three children are suddenly confronted with the question, "Who took the candy?" Two chorus out "Not me! What candy?" The third, after ten seconds, in a more subdued voice, responds "Not me." The temporarily inhibited reply and the entire absence of interest in "what candy" clearly prove the presence of important elements in the situation to which the third child is responding that are absent in the case of the other two.

The response is the sum total of the behavior brought about by a situation affecting an individual. It includes movements produced by the large muscles of the body or of the small muscles within the body, and the total of consciousness involved therein.

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LESSON 56

HOW DOES ONE ESTIMATE DISTANCE? (continued)

In Lesson 54 we discovered that the visual impressions received by the two eyes are not identical. And the same fact was discovered concerning two stereoscopic pictures. Moreover, we ascertained that there was a greater difference between those details of stereoscopic pictures which were in the foreground than between those in the background. Depth or perspective is clearly added to a picture when two views thus constructed are seen together. How is this accomplished?

The two eyes must rotate more (converge) when fixated on a near object than on a distant object. From experience, we have learned when we fixate on a string attached to a window curtain that (a) it is this string (not some other object) and (b) it is about so far from us. The object aspect of the response is due to stimulation of the retina by waves of light from the string, which in turn transmits a stimulation over the optic nerve to the brain. The distance aspect is due to the kinaesthetic sense-organs in the muscles that rotate the eye in order to fixate it on the string. They are stimulated to a certain extent and this stimulation is transmitted over nerve fibres to the brain. There these particular stimulations cause us quite unconsciously to add to the object-aspect the idea of the string being located so far from us. The total perception—string so far from us—is a fusion, then, of visual and kinæsthetic stimulations.

Photographs taken for a stereoscope are taken by two cameras placed side by side but somewhat farther apart than the distance between the two eyes. The photographs over-emphasize the difference in the two views as seen by the two eyes. When using a stereoscope, one must converge his eyes more in order to have both eyes fixated on near objects than on distant objects in the two pictures. Consequently, we think of them as nearer because always in life when we have to converge our eyes upon an object it is nearer than an object which requires less convergence.

The above is the explanation of how in binocular vision we determine distances up to 100 feet. At 100 feet the eyes are both fixated straight ahead. Consequently there can be no greater divergence for objects beyond this distance than for 100 feet and, accordingly, we can not estimate distances beyond this distance on the basis of convergence and divergence.

Now how do we estimate distance up to 6 feet with monocular vision, and, second, how do we estimate distance beyond 100 feet? It is perfectly apparent that we can do both these things.

Experiment

Problem.—What are the Factors Underlying the Perception of Distance? (Continued.)

Apparatus.—Three pins.

Procedure:

1. Have S close one eye and then have him note the changes that occur in the appearance of a pencil and the resulting sensations in the eye as E moves a pencil towards and away from the eye within the limits of an inch and six feet. Is S ever at a loss to know just how far the pencil is from him?

2. In order to determine how accurate is S's ability to estimate relative distances, stick two pins into the far end of a table, say six feet from S. The line of the two pins should be perpendicular to S's line of vision. Now place the third pin between the other two sometimes in front of them and sometimes behind them and ascertain how accurately S can determine the relative distance of the middle pin as compared with the two outside pins. When this has been done, repeat the experiment, S using only one eye. (Make sure there are no shadows cast by the pins.)

Just as a camera has to be adjusted for focusing on near and distant objects, so the lens of the eye has to be correspondingly adjusted. As has been pointed out in Lesson 53, these adjustments are made by contractions or relaxations of the ciliary muscle which is attached to the lens. Located in and about the ciliary muscle are kinæsthetic sense-organs. Ordinarily we are unconscious of the sensations aroused by these sense-organs. But when the pencil is brought close to the eye, the strain in the ciliary muscle, in order to secure a clear focus, is so unusual that we notice it. Although we are not ordinarily conscious of the

kinæsthetic sensations caused by movements in the ciliary muscles, yet we act in terms of them. That is, through experience we have learned that when the eyes are focused on a very near object, the ciliary muscle is under a certain strain, whereas when the object is farther away this strain is different. Consequently when confronted by an object, the first reaction is to focus it on the retina (a reflex act unconsciously done). We then receive (a) visual stimulations from the object which give us our knowledge of the object and (b) kinæsthetic stimulations from the ciliary muscle which give us our knowledge of the distance of the object from the eye. Rather the two—visual and kinæsthetic—sensations fuse together and we perceive such and such an object at such and such a distance. The above mechanism is an aid to us in estimating short distances say of six feet and less.

3. Can an individual blind in one eye utilize the factors involved in binocular vision in estimating distance? Recall the details discovered in Lesson 54, part 2, with the books C and D. Note also in the same way, but with one eye, the differences in the view of book D obtained by swinging the head from side to side.

Repeat the above procedure, but, instead of moving the head from side to side, walk from your window to the next and note such changes as may occur in the view of objects at a considerable distance from you.

4. Finish up your study of the other factors involved in the estimation of the distance of objects over 100 feet away.

Results.—Report your results in the best way you know in order to bring out the principal points of the experiment.

Questions.—1. In what way does one estimate distances up to six feet?

2. In what way does one estimate distances of from 6 to 100 feet?

3. In what way does one estimate distances over 100 feet? Consider also the following questions in this connection:

(*a*) If one did not know the size of an object, say a low hill, would that affect his estimation of its distance? Why? Explain.

(*b*) Is the same distance estimated differently on a foggy day from what it is on a clear one? Why do Easterners underestimate distance in Colorado?

(*c*) Do differences in color affect the estimation of distance? How? Why?

(*d*) Which is easier to estimate the distance of, (a) a man walking along a road, (b) an auto, (c) a train along a railroad track, or (d) an aeroplane in the air? Why? How is the estimation made?

(*e*) What part can a shadow play in the estimation of distance?

Application.—

Hand in your report at the next class-hour.

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(It is not necessary, nor is it expected of students, to consult these references in writing up the experiment. They are listed here for the use of any who are interested and wish to devote *extra* time to the subject.)

LESSON 57

MECHANISM OF THE CONNECTING SYSTEM

We now have a fair conception of how a sense-organ is stimulated into activity by outside agencies. We also realize that when a muscle or a group of muscles is stimulated, it contracts and moves a portion of the body. And, from the illustrations given in Plates XLI and XLII, we have obtained a general notion as to how the stimulation received in the sense-organ is finally transmitted to the muscles and they in turn react. In those three examples we have cases in which the current flows from the skin to the muscle (a) by way of the spinal cord, (b) by way of the mid-brain, and (c) by way of the cortex of the brain. About these three examples we can build a great deal of the total conception that is necessary in understanding the connecting system.

The first three points to get clear in understanding the nervous system are: First, *sense-organs are connected with muscles by way of a central station in the spinal cord, mid-brain, or cerebrum.* Second, *the nervous system is made up of these three centrals together with nerve-fibers running to the sense-organs and to the muscles of the body.* Third, *the function of the nervous system is to connect sense-organs with muscles.*

In order to obtain a clearer, more accurate conception of the connections which are made possible by the nervous system, it will be necessary to obtain a better idea of the anatomy of the nervous system.

The nervous system can be roughly divided into four parts: (1) the spinal cord, (2) the mid-brain, (3) the cerebrum, and (4) the nerves that connect these parts with sense-organs and muscles. All of these four parts are composed of something like 11,000,000,000 nerve-cells combined in various ways.

The Neurone

In Plate XLVI are shown six different nerve-cells or neurones as they are more often called. At first glance they do not look much alike. A closer study will show that they all have certain

characteristics in common. Each nerve-cell has (1) a *cell-body* and (2) certain projections from the cell-body called *filaments*. The cell-body is composed of protoplasm and has a nucleus. The filaments can be divided into two kinds: the axon and the dendrites. A nerve-cell has one *axon* but it may have many *dendrites*. The axon can be likened to a cable of telephone wires. It is made up of many fibrils similar possibly to the separate wires

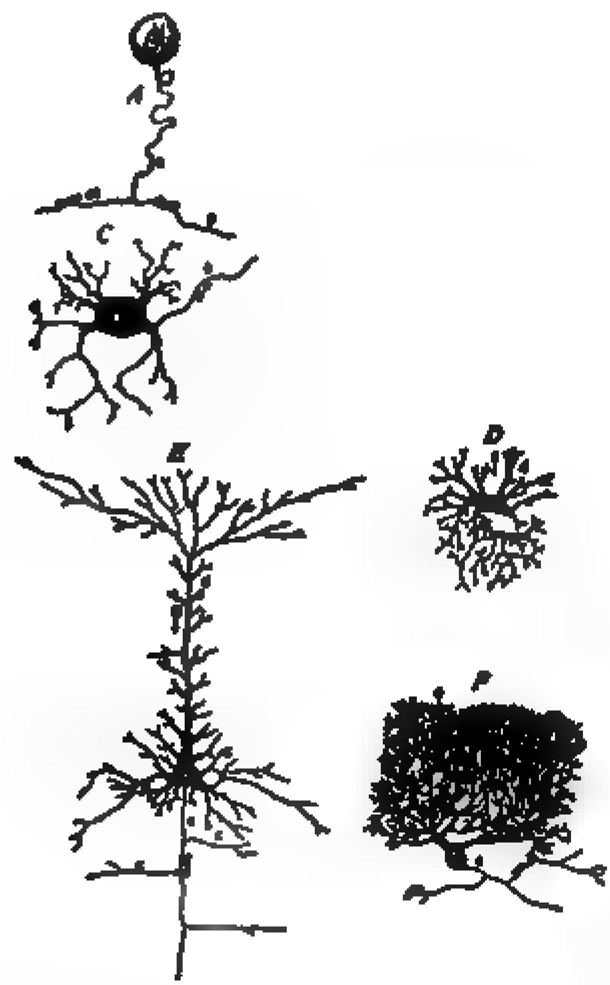

PLATE XLVI.—A, cell from the spinal ganglion; B, cell from the ventral horn of spinal cord; C, cell from the sympathetic, D, cell from the spinal cord; E, pyramidal cell from the cerebral cortex; F, cell from the cerebellar cortex; a, axones; d, dendrites; c, collaterals; p, peripheral part of the fibre; cl, central part. Arrows indicate the direction of conduction for nervous impulses. (Modified from Morris and from Toldt.) (From J. R. Angell, *Psychology*, 1909, Figure 2.)

in the cable. Around these are one or two sheaths, possibly of an insulating character but more probably for the purpose of supporting and nourishing the fibril core. Axons may be infinitesimally short or up to five feet in length in man. Ordinarily they have few subdivisions. A bundle of such axons make up a nerve. The other type of filament, the dendrite, is usually quite short and much branched, often suggesting a bush.

The neurone has certain characteristics in common with all living cells. It is *irritable*, by which is meant that it responds to certain stimulations. It possesses *conductivity*, by which is meant that a stimulation at one point of its body is transmitted to any other part of its body. Besides these two, it probably has also the function of either *reinforcing or inhibiting the impulse* communicated to it. To illustrate the reinforcing function, consider the fact that a relatively slight pull on the trigger of a gun will produce a relatively great response. The stored-up energy in the cartridge is set off at the slight impact. In somewhat the same way a nerve-cell may be only slightly stimulated but it may respond in such a way as to stimulate very much more strongly the next cell in the series. The neurone as a whole then receives and transmits stimulations and in doing so may increase or decrease the intensity of the stimulation.

Turning now to the functions of the various parts of the neurone, we must note that "the cell-body has the highly important function of serving the nutrition of the whole neurone; it is necessary for maintaining the axon and dendrites in proper condition for work, even though it may take no peculiar part in the actual doing of the work."[1]

The axon carries impulses away from the cell-body, while the dendrites receive impulses from without and transmit the stimulation toward the axon. In thinking of the neurone as a link in the chain connecting a sense-organ and muscle, we must always think of the current first stimulating the end of a dendrite and of it then being transmitted over the dendrite to the axon and out the axon. The nervous current never flows in the reverse direction.[2]

The Synapse

The *synapse* is the point of contact between an axon and a dendrite. It is still a debated question whether there is actually a gap between the axon and dendrite or not, but it is certain that as far as their function is concerned we may speak of the synapse as a functional gap. From physics we know that a weak electri-

[1] Ladd and Woodworth, *Physiological Psychology*, 1911, p. 288.

[2] The above is true except in the case of the sensory neurones connecting sense-organs with the spinal cord. Here the axon on leaving the cell-body divides and one branch goes to the sense-organ and the other into the spinal cord.

cal current will jump across a small gap in the form of a series of small sparks, but it will not jump a large gap. If the strength of the current is increased, the current will again jump a larger gap in a series of larger sparks. The smaller the gap, then, the less the resistance and consequently the smaller the current needed to jump the gap. This conception was early applied to the synapse. It was supposed that the dendrite and axon actually moved toward or away from each other and in doing so decreased or increased the resistance to the nervous current. This physical conception has been discarded and in its place is now a chemical one. Due to chemical changes in the dendrite and axon, the resistance is changed.

It is a well-attested fact that the nervous current flows over an axon at about the rate of 100 feet per second, or approximately an inch in 0.0008 second. But it requires 0.004 second for the current to cross a synapse, an extremely short distance. This rate across a synapse is, moreover, for a well used synapse. It is quite likely that the rate is much slower for a little used synapse.[1]

Modern psychology makes much of the synapse with its great resistance to the passage of the nerve impulse, together with its changing resistance, in explaining the formation of habits. A habit or memory is today conceived of as due primarily to the chemical change in the synapse whereby the resistance is lowered, thus permitting the nervous current to flow in this particular direction rather than in some other direction. (Review here the discussion in Lesson 13 under the heading "Physiological Basis for Retention.")

Functioning of the Nervous System

By this time it should be clear that all kinds of behavior are essentially composed of one or more sense-organs and one or more muscles, with their connecting neurones. In some cases the sensory neurone directly stimulates the motor neurone, in other cases many neurones are interposed between the two. We may divide up all action of man on the basis of these interposing neurones. We have already spoken of the *three levels:*

[1] A. T. Poffenberger, Reaction Time to Retinal Stimulation, *Archives of Psychology*, 1912, Chap. VII.

1. Connection through the spinal cord.
2. Connection through the mid-brain.
3. Connection through the cerebrum.

The three levels differ primarily in the directness with which the transfer is made. The higher paths permit more connections and make possible the cooperation of a greater number of sensory impulses in the control of movement.

The Lower Level—Spinal Level, (*See Plates XLI and XLII*). An essential trait of the lower level has already been repeatedly pointed out, i. e., a direct stimulation from the sense-organ results in an immediate response by an appropriate muscle. Examples

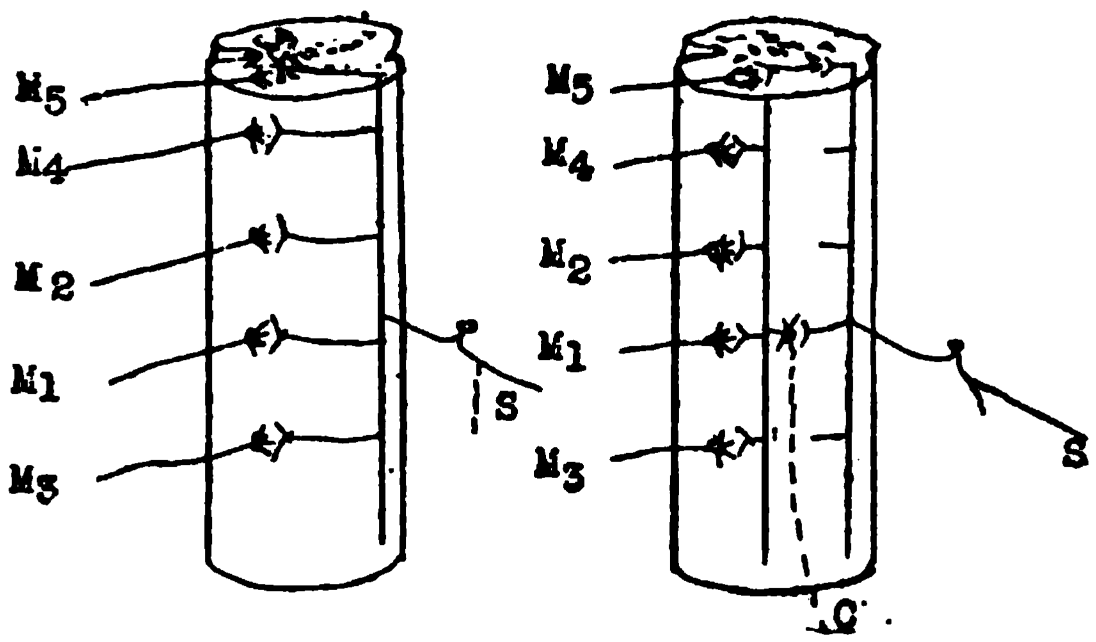

PLATE XLVII.—Showing how a sensory neurone (S) may be connected directly with various motor neurones (M) or indirectly by means of connecting or intermediate neurones (C). From J. D. Lickley, *The Nervous System*, 1912, p. 40.

of such reflexes are: jerking the hand away from a hot stove, and withdrawing the part from tickling. In reflexes we have the proper action, resulting because our nervous system has been developed through ages of experience to act this way.

Thus far we have considered the simplest form of reflex act, due to the union of one sensory neurone and one motor neurone. But we may have reflexes in the spinal cord where a few or many connecting neurones intervene between the sensory and motor neurones. If the brain of a frog is destroyed all the customary reflexes may be called out by appropriate stimuli. If a bit of paper moistened with acid be placed upon the left foot of a frog (1) the leg will be drawn up—a simple reflex. If now the foot be held so that it cannot be moved, it will be found that (2) the other foot is brought over to remove the stimulus. If this is not

successful, (3) the muscles of the forelegs and trunk will contract and the contractions will continue until the stimulus is removed or the organism becomes exhausted. (The same phenomena can be obtained through tickling a person who is asleep.) What has happened in all these cases? In Plate XLVII is shown very roughly the organization of the neurones involved in such cases. In the first case the current travels from S (the sensory neurone) to M, a motor neurone. With continued stimulation received via S more and more motor neurones are brought into play, as M_2, M_3, M_4, M_5, etc. What is much more likely to happen is depicted in the right hand part of the Plate where an intermediate or connecting neurone (C) is included. Here the current travels from S to C and then to M_1, or M_2, M_3, etc.

Now why have there been these changes in response? We must suppose that continued stimulations result in an increase in the nervous current which is generated. With a slight amount of current the flow is over the most usual pathway because of less resistance at the synapse. When that pathway is blocked, the next easiest pathway is used. And with greater and greater amounts of nervous current coming in over the sensory fibre, greater and greater resistance can be overcome, resulting in more and more widely separated motor cells being stimulated—hence in more and more extended muscular contractions. (Review at this point the conception of "overflow of energy" given in Lesson 9 and "defensive type of self-assertion" in Lesson 34.)

The Intermediate Level—Mid-Brain Level.—The mid-brain, or brain-stem, is the upper end of the spinal cord. In this elementary course it is impossible to consider the parts of the mid-brain separately, and so all of them will be considered together. Their functions are very complex, but after all they may be reduced to the same ones which appear in the spinal cord, i. e., connecting sense-organs with muscles, and more particularly connecting impressions from many sense-organs together so as to have the most appropriate muscular response to all the sense-organ impressions. The functions of the mid-brain are *first*, to serve as reflex centers by which the sense-organs of the head may be connected with the muscles of the head. To illustrate, note these examples. According to the amount of light striking the eye, the pupil is wide open or shut. These move-

ments of the pupil result from stimulations from the retina going to the mid-brain and back again to the muscles governing the pupil. In the same way most of the movements of the eyes are governed from the mid-brain. The medulla, a part of the mid-brain, receives organic stimulations from the various parts of the body and in turn stimulates the muscles of the heart, blood-vessels, etc., so as to control the rate and force of the heart-beat, the diameter of the blood-vessels, etc. A *second* function of the mid-brain is to connect the special sense-organs of the head with the motor neurones of the spinal cord, and so with the muscles of the trunk and limbs. For example: Putting the hand up to protect the face, jumping at a loud noise, kicking backward as the result of a blow on the head from behind. *Third*, the mid-brain connects the cortex with sense-organs and with muscles. It is probable that all the sense-organs excepting smell, are represented in the mid-brain by neurones, and that in every case the impulse from a sense-organ is relayed from neurone to neurone in various ganglia in the mid-brain. The mechanism of the reflexes in this level is then the same as in the lower level. The only difference is that the causes of excitation are more numerous and the possibilities of connection are greater.

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LESSON 58

MECHANISM OF THE CONNECTING SYSTEM (continued)

THE CEREBELLUM

See Cb of Plate XLVIII, and the smaller body just above TA in Plate XLIX for the location of the cerebellum. The cerebellum belongs to the mid-brain level from its position, but because of its cortical structure it may be considered here. It is very richly connected by neurones with the lower centers and with the cerebrum. But we know very little about its functions. It seems, however, to be agreed that its functions are most intimately related to the reception and coordination of the sensory stimulations which originate *within* the body itself, e. g., in the muscles, the viscera, the semi-circular canals of the ear, etc. It is thus conspicuously involved in such actions as those by which we preserve our equilibrium and in general succeed in carrying forward well coordinated and balanced movements, like walking, sitting, and standing.

THE CEREBRUM

Many stimulations from sense-organs are relayed in to the cerebrum, are there combined into an organized whole and then relayed out to the muscles resulting in coordinated movements in harmony with the stimulations received by the sense-organs. The activity may be likened to the army organization. Information is obtained by the soldiers and lower officers while on scouting duty. This information is transmitted up through the various officers until it finally reaches the commanding officers. These officers, in turn, transmit orders back down through the various officers until finally the soldiers execute them. A general ordinarily neither receives information from a private nor gives him commands. So with the brain, it never receives stimulations directly from the sense-organs (excepting smell) nor directly

stimulates muscles to move. The lower and intermediate levels of activity stand in between. Consider another illustration. The problem 673 × 48 is given one to solve. Light waves from the paper containing the problem strike the retina. The physical stimulation is changed into a physiological process which is

PLATE XLVIII.—The figure at the left shows the general relations of the central nervous system to the bones of the skull and spine. The figure at the right displays the general contours of the central system as seen from in front. The great ganglionated cord of the sympathetic system is shown attached to one side of the spinal nerves; the other side has been cut away. (Cer) the cerebral hemispheres; (O) the olfactory centers; (P) the pons Varolii; (M) the medulla oblongata; (Cb) the cerebellum; (Sp. C) the spinal cord; (I) the olfactory nerve; (II) the optic nerve; (III) the oculo-motor nerve; (IV) the trochlear nerve; (V) the trigeminus nerve; (VI) abducens nerve; (VII) the facial nerve; (VIII) the auditory nerve; (IX) glossopharyngeal nerve; (X) the vagus nerve; (XI) spinal accessory; (XII) the hypoglossal nerve; (C) the first cervical spinal nerve; (DI) the first dorsal, or thoracic nerve; (LI) the first lumbar nerve; (SI) the first sacral nerve; (XI) filum terminale; (CSI) superior cervical ganglion of the sympathetic; (CS2) middle cervical ganglion of the sympathetic; (CS3) and (DS1) junction of the inferior cervical and the first dorsal ganglion of the sympathetic; (DSII) the eleventh dorsal ganglion of the sympathetic; (LS1) the first lumbar ganglion of the same system; (SS1) the first sacral ganglion also of the sympathetic. From J. R. Angell "*Psychology*," 1909. (Figures 12 and 13.)

transmitted over the optic nerve to the mid-brain. Here part of the stimulation is directed to muscles controlling the eye and

head and they so move as to permit one to see the problem in the best light, etc. The remainder of the stimulation is relayed to the cortex of the brain. Due to long established habits the stimulation is then sent from the cortex back through the mid-

Plate XLIX.—"Localization of Cerebral Function. The lower figure shows the outer surface of the right hemisphere; the upper, the mesial surface of the left hemisphere. In both figures the motor areas are marked by horizontal shading, the sensory by vertical shading, while the associatory areas are unshaded. The doubtful or partially sensory or motor areas are indicated by dots. (S) is opposite the fissure of Sylvius; (R) above the fissure of Rolando. (M) is above the motor region; (C) above the cutaneous and kinæsthetic area. (V) indicates the visual region; (O) is below the olfactory region. The auditory region is just below the fissure of Sylvius, above (H). (FA) designates the frontal, (PA) parietal, and (TA) the temporal association centers. There is some evidence that the dotted regions about the sensory and motor areas are areas in which particular associations are formed with them. The diagram embodies the results of A. W. Campbell, but has been modified in one or two respects to agree with the results of Flechsig and Cushing." (From W. B. Pillsbury, "*The Essential of Psychology*, 1911, Figure 7, published by the Macmillan Company.)

brain down the spinal cord and to muscles of the arm and one finds himself reaching for pencil and paper and solving the problem.

It is probable that only connections made in the cerebrum are *conscious*. That is, consciousness accompanies only cortical activity.

The cerebrum is composed of two hemispheres joined together by what is called the *corpus callosum*. This is shown in Plate XLIX as a sort of crescent shaped area in the center of the upper illustration. This represents the cut-end of the callosum as it must need be severed in order to show the inner surface of one of the hemispheres. It is made up of fibers which connect one hemisphere with the other. Two landmarks need to be pointed out, the *fissure of Rolando* and the *fissure of Sylvius*. The former is marked by the letter R in the plate and the latter by the letter S.

Recent study of the brain has shown that certain areas of the cerebrum are concerned with certain functions, some being primarily concerned in receiving stimulations from the sense-organs and others in controlling movements in the body.

Sensory Areas.—(1) Cutaneous sensations are localized just back of the fissure of Rolando (marked by a C in the plate). Stimulations from the leg are localized at the top of this area and over on the inside surface, stimulations from the trunk are localized further down toward the fissure of Sylvius, and stimulations from the head at the lower end of the area not far from this fissure. Destruction of this sensory area does not affect all varieties of cutaneous sensations equally. "The pain sense is little or not at all affected, except temporarily; the sense of pressure and contact is considerably more diminished; the temperature sense is so much reduced that only extremes of heat and cold are perceived; the muscular sense is almost entirely destroyed; and the perception of form, size, location, etc., by use of the hand is usually abolished."[1]

2. Visual sensations are localized in the occipital region of the cerebrum, marked by a "V" in the plate. "It would appear likely that the retinas are projected, point for point, though perhaps not quite so minutely as this, upon the visual cortex."[2] Injuries to certain parts of the visual area produce blindness as related to corresponding parts of the retina. We may speak of two types of localization here: one which deals with the reception of the simple stimulations received from the eye—corre-

[1] Ladd and Woodworth, *Physiological Psychology*, 1911, p. 245.

[2] Ladd and Woodworth, *op. cit.*, p. 248.

sponding to awareness of brightness or color, and the other which deals with the interpretation of these simple stimulations going to make up definite objects, as yellow square, a house, or what not. Injuries to the more outlying parts of the visual area result in loss of ability to recognize objects, or to read, or to utilize vision for purposes of orientation. In such cases the patient can still see, but has lost some of the uses of sight. Such cases are referred to as psychic blindness.

3. Auditory sensations are localized below the fissure of Sylvius, and appear a little above where the H occurs in the plate. Injuries to this area, as in the case of the visual area, produce total deafness or psychic deafness. The latter is illustrated by such cases as inability to understand spoken words, or to apprehend melodies.

4. Olfactory and taste sensations are located in a great loop about the corpus callosum.

The Motor Area.—Voluntary control of muscles of the body is located in an area just across the fissure of Rolando from the cutaneous sensation area. And here again as in the case of that area, the legs are represented by the upper part of this area, the body next, the arms next, and the head at the lower end. In this area are the largest nerve-cells in the body. Their axons descend through the mid-brain and spinal cord and there come in contact with the dendrites of other motor cells. Axons from the latter proceed out to the muscles of the body.

In paralysis we have a condition in which the motor connection with the muscle has been destroyed. If the injury is in the motor-cells of the cerebrum the paralysis relates only to voluntary movements, while reflexes of the spinal and mid-brain level are not ordinarily affected. If the injury is in the spinal cord but above the motor-cells in the cord then the mid-brain reflexes are destroyed as well as all habitual movements. If finally the injury is in the motor-cells of the spinal cord then there results complete paralysis of the muscles of the body controlled from that part of the spinal cord.

Another type of paralysis is due not to a destruction of the motor connections but to a destruction of the sensory side of the arc. This type is found, for example, in tabes dorsalis. The incoming kinæsthetic sensations are largely eliminated because the sensory connections are destroyed. Walking is seriously

interfered with because one cannot sense just where his leg is at any moment. Through training such individuals may be taught to guide their movements not as they have done in the past in terms mainly of kinæsthetic stimulations but in terms of visual stimulations. In this way they are able to walk with little suggestion of "drunkenness."

The Parietal Lobes (marked PA in the Plate) are situated between the cutaneous sensation area and the visual area. Injuries to these lobes are distinguished by disturbances in ability to connect ideas and sensations with their proper companions. For example, a file touched in the dark does not call up the idea of a file as seen. In other words, things seen are not connected up with their auditory or tactual appearance and hence are improperly understood and interpreted.

Frontal Lobes.—Injuries to the frontal lobes seem to be marked by "disorders of attention," concentration, and the higher mental and emotional capacities. "An addiction to practical jokes of a weak order, with lack of respect for property or the rights of others has been frequently observed. On the other hand, in some remarkable cases of destruction of large parts of the frontal lobe, no marked symptoms whatever have appeared." This is true more particularly of the right frontal lobe than of the left. Franz first taught a cat and monkey a trick, then removed parts of the frontal lobe. In general the trick was no longer known. Injury to only part of the lobe resulted in simply slowing down the time of performance. Franz concludes that "the frontal lobes are concerned in the acquisition of new performances, but that no one spot is indispensable for the acquisition of a particular act; and that long continued practice in a performance reduces it to an automatic or semi-reflex condition, in which the frontal lobes are no longer necessary."[1]

Association Centers.—A rather small portion of the surface of the cortex is thus far accounted for. How shall we explain the function of the remainder of the brain's surface? The best authorities would explain the function of this remainder as one of *association*, or of connection. By this is meant that here the stimulations from the various sense-organs are combined together, thus affording responses which are appropriate to the whole sensory stimulation.

[1] Ladd and Woodworth, *op. cit.*, p. 262–63.

For example, the reflex act would be to drop a flat-iron, if the handle were too hot. But if there were a kitten on the floor at one's feet the resulting action would be to throw the iron into a corner or to hold on to it until safely replaced on the stove. In the second case the reflex act is prevented by the visual stimulation—the sight of the kitten. In such a case the cerebral cortex was directing the movement of carrying the hot iron. The reflex act of dropping was inhibited (when the iron was put back on the stove) or directed into a new movement (throwing the iron) by the stimulation coming from the eye. The association centers are supposed to be responsible for such coördinated action.

Before leaving this subject attention should be called to the fact that the four phases of knowledge of a language are generally considered to be located in four different parts of the cerebrum. Ability to read is localized in the visual area, ability to understand spoken words is localized in the auditory area, ability to speak is localized in the motor area near the center governing muscles of the head, and ability to write is localized in the motor area near the center governing arm movements. It is then possible through a particular brain injury to lose the ability to read but still to understand what another says, or to speak oneself and, what is even more surprising, to be able to write, although, of course, unable to read what one has written. The teaching of English, for example, must consequently be viewed as the development of four groups of habits, instead of one. It is not enough to train a student to write good English; he must also be trained specifically to speak good English. There is no doubt that training in one of these four groups aids in the other three. But too much reliance has been placed upon this in the past. Since it is a fact that the brighter the child the greater will be this transfer, and the duller the child the less the transfer, teachers should deliberately aim to develop all four groups for the sake of the dull child.

Fundamental and Accessory Systems

Another method of grouping the complicated functions of the nervous system is to refer to them under the two headings—fundamental system and accessory system. These terms are

used so frequently it is desirable to become familiar with them in this course.

"The nerve-centers of vertebrates may be considered as consisting of (1) *a fundamental system*, comprising the spinal cord and brain-stem, and (2) *accessory organs* developed as outgrowths of the brain stem, the chief of these being the cerebellum and cerebrum. (See Plate XLVIII.) The development of the accessory structures is very unequal in different forms of vertebrate animals: the size of the cerebellum being closely related to the animal's powers of locomotion, and the size of the cerebrum with his powers of learning new and specific adaptations. The fundamental system is, on the other hand, fairly constant throughout the vertebrate series. This is especially true of the spinal cord, the size of which seems to depend almost wholly on the size of the animal."[1]

The fundamental system consists of: (1) *Sensory ganglia* which lie just outside the spinal cord. (In Plate XLI of Lesson 51 one sensory neurone is shown extending from the skin at B into the spinal cord at L. Its nerve-cell is at K. A cluster of such nerve-cells is called a ganglia.) From these ganglia fibers extend out to the sense-organs of the body on the one hand and into the spinal-cord on the other. It is in this way that the sense-organs are connected with the spinal cord, with the single exception of the sense of smell. Here the sense-organs send out their own fibres which extend into the brain. (2) *Motor-cells*, which lie within the spinal-cord, branches of which pass out to the muscles. (3) *Central-cells*, whose branches do not extend to sense-organs or muscles, but which run up or down or across in the spinal-cord and so bring all the different parts into connection. Most of these fibres are short, but there are some sets of long ones, which connect the spinal-cord directly with the mid-brain. The usefulness of these connecting fibres can be readily appreciated as by means of them the impressions from all the sense-organs may be combined and thus movements may result which are in harmony with the information received from eye, ear, nose, etc.

The accessory system is composed principally of the cerebellum and cerebrum. In terms of evolution, these are recent additions to the nervous system, as contrasted with the elements making up the fundamental system. The functions of these two organs

[1] Ladd and Woodworth, *op. cit.*, p. 26.

has already been discussed. In addition, the accessory system is characterized by long nerve fibres which connect the cerebrum more directly with lower centers. These nerve fibres are spoken of as "long" in contrast with the short interconnections of the fundamental system. But the accessory system, as already pointed out, never receives stimulations from sense-organs (excepting smell) nor transmits stimulations on to the muscles except by the way of the fundamental system.

INDEX

(Bold-face numbers refer to Book Two)